NOTES ON

PATHOLOGY

GUITERAS

ORAG

Dropsies

mechanical
as diseases
of heart, liver,
lungs, Kidneys

metabolic
changes in Blood
vessel walls and ti
surrounding b.

Causes of fatty degeneration are lack
oxygen

Poisons
like alcohol
chloroform

(2) Anaemias

(3) Traumatism

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Ziehls Method of Staining.

(1) Fuchsin 1 pt (the Mordaunt)
5% aq. sol of carbolic ac. 90 pts.
Absolute alcohol 10 pts.

2. ℞
℞ Gabbets sol.
Methyl blue 2 pts
25% H_2SO_4 100 pts

The Mordaunt the capsule and enables the Fucsin to reach the nucleus. The counter stain contains the differentiating fluid the (H_2SO_4).

Tubercular Bacillus

1 Irritant
necrosis
Inherent properties of the bacillus itself

2 Pos Chemotactic

3 Produce Ptomains
Sets up hyperaemia and tubercles are rapidly spread

J. J. 28. Time
Dr. Massey.

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Chronic Interstitial Nephritis

Localized
↓ yphalitic
↓ Embolic

Diffuse
Secondary
(following chronic
parenchymitous)
Fatty and Contracted
Kidney

Idiopathic
General
condition

1 Acute Parenchymitous
large Kidney

2. Chronic Parenchy.
= large White Kidn

3 Late Stage Chronic Parench
= Fatty and Contracted
{ Variegated appearance on section.

4 Diffuse chronic Interstitial
= Red granular kidney
{ Uniform red appe
ance on
section.

NOTES

—ON—

THE LECTURES OF

PROF. JOHN GUITÉRAS

—ON—

GENERAL AND SPECIAL PATHOLOGY,

DELIVERED BEFORE THE

First and Third-Year Students of the University of
Pennsylvania.

ARRANGED BY

Allen J. Smith, M. D., formerly Quiz Master in Pathology in the Medical Institute, Prof. of Pathology at the University of Texas;

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PREFACE.

THESE notes are offered to the students by the kind permission of Prof. Guitéras, to whom our warmest thanks are due for his uniform courtesy and support. We trust that they will be found useful to the students, and that in our efforts to be brief as few inaccuracies as possible have crept in. The illustrations, we feel, will materially aid in fixing in the mind the text of the lectures. It has been necessary, unfortunately, to place the First-Year Notes in the latter part of the book.

Bequest of Dr. Clarence J. Marshall

818538

CHAPTER I.

Pathology is the science of disease; or, more accurately, Pathology is that branch of the science of medicine which has for its object the study of the manifestations of energy and changes in structure which take place in the diseased living being.

By "*disease*" we mean all those modifications of the normal manifestations of life which impair more or less the adaptability of the individual for the surrounding media. By "*a disease*" we mean a group of such modifications of sufficient regularity of occurrence to constitute a distinct species.

The study of pathology, then, includes not only the changes in structure, the anatomical study of diseased tissues and organs, but also changes of function, the manifestations of energy of diseased parts. Now, which of these comes first—change of structure or change of function? From mechanical principles we infer that changes of function follow changes of structure; but at the same time we know that no structural change can occur without some exercise of force to bring it about. This first force or energy we take to be certain obscure, primary, functional derangements, which cause structural alterations, and these, in turn, secondary changes of function. The last are manifest as the symptoms of the disease.

Divisions of Pathology.—*Ætiology*, the study of the cause or development of disease.

Morbid Anatomy, the study of the changes of structure in disease.

Morbid Physiology, the study of the changes of function in disease.

Similarly, Biology is divided into Embryology, Morphology, and Physiology.

Pathology further may be divided into *General* and *Special Pathology.* **General Pathology** is concerned with the morbid changes of structure and function that may occur in any tissue or organ; **Special Pathology** with such as occur in special organs. These changes of function and structure are spoken of as morbid processes.

GENERAL PATHOLOGY.

Morbid processes are of two kinds: elementary and compound. The *elementary* are the elements out of which diseases are made up. They may also be described as the changes which occur in individual cells. *Compound pathological processes* are such as are more complicated, being composed of two or more elements.

Elementary pathological processes may be progressive or retrograde, or better, integrating or disintegrating. Of the former, hypertrophy and hyperæmia are examples; of the latter, atrophy and degenerations. The former elevate the condition of the tissue; the latter lower it.

HYPERTROPHY.

This is not easily defined, but may be said to be an increase in the size of a tissue or organ, occurring independently of the general growth of the organism and without marked alteration of the cellular relations. Not all enlarged organs are hypertrophied.

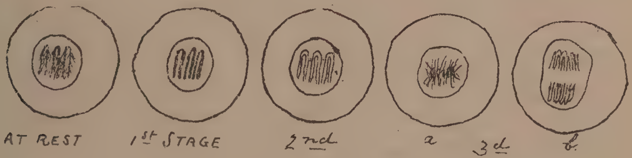
Hypertrophy may be divided into: (1) *Simple*, or that in which the individual cells increase in size, and (2) *Numerical*, or that in which there is increased number of cells. The process in the former is simply growth, in the latter multiplication or proliferation. Usually in the hypertrophy of an organ there is a combination of the two. As occurring alone, the numerical form is more common, or at least the more common *demonstrably*. Simple hypertrophy is hard to demonstrate, this being readily done only in the case of the uterus and heart, which furnish the best examples of simple hypertrophy. Numerical hypertrophy is sometimes called *Hyperplasia*.

From the standpoint of the organ we have: (1) *True* and (2) *False Hypertrophy*, or *Pseudo-Hypertrophy*. True hypertrophy is such as is accompanied by no change in the arrangement of the cellular constituents, while in false hypertrophy we find only one of the components involved, and that usually the unimportant one—the connective tissue. In true hypertrophy there is increase of function; in false, diminution.

True hypertrophy is caused by increased functional demand on an organ. This demand may be—(*a*) direct, as in the case of the uterus in pregnancy, or (*b*) indirect, vicarious, or supplementary, when the demand is due to imperfect action of a companion organ. Examples of the latter are seen where a kidney hypertrophies because of removal of its fellow, or the heart because of disease and inadequacy of the kidneys. Another example of true hypertrophy is that of the small vessels into large ones in the formation of collateral circulation after ligature of an artery. Of false hypertrophy, examples are: *Pseudo-hypertrophic Muscular Paralysis* and *Hypertrophic Cirrhosis of the Liver.* In both of these the connective tissue is increased.

Cell-proliferation demands careful study. This proliferation may be accomplished by two methods: (1) Direct cell-division, or *Amytosis*, or (2) indirect cell-division—*Karyomytosis*, or *Karyokinesis*. The latter is of prime importance. The **nucleus** at rest is composed of a network of threads which stain deeply with the "nuclear" stains, such as hæmatoxylon, saffranin and gentian-violet,—this being called the *chromatin*, or filamentary substance, in contradistinction to the interfilamentary substance, or *achromatin*, which stains poorly. *Mytome* is another name for this appearance of the filamentary portion. The arrangement of the chromatin filaments is like the letter **U**, the joined portion of each loop being at one side of the nucleus, the open ends at the opposite. From these primary loops spring secondary filaments which finally so interlace as to give a compact appearance.

In **Karyokinesis** the study of these loops is most important, and we recognize three stages:



(1) Thickening of the primary, disappearance of the secondary filaments.

(2) Longitudinal splitting of the filaments.

(3) Rearrangement of the filaments:—

(*a*) Monaster or Mother Star; (*b*) Amphiaster, Double Star or Daughter Star.

After the completion of these processes, the cell-body and nuclear body constrict and finally divide, leaving two cells, each with its nucleus.

Special methods of study are necessary to demonstrate these appearances. The hardening must be rapid. Absolute alcohol is too slow. We use a solution of 15 parts of a 1 per cent. ~~picric~~ chromic acid solution, 4 parts of a 2 per cent. osmic-acid solution with 1 part of acetic acid. The bits of tissue, not above 1 cu. cm., are allowed to remain in this fluid twenty-four hours and are then placed in absolute alcohol. The tissue must be removed from the body within six hours after death. The best stain is saffranin. Thin sections are placed in a solution composed of equal parts of saturated alcoholic solution of saffranin and alcohol *or* water (the one or the other as suits the individual case best), and, after a few moments, differentiated in a solution of 1 part of hydrochloric acid to 1000 parts of absolute alcohol. When clouds of color cease to come off, the specimen is taken out and mounted. The nuclear figures are found dark reddish-brown, the general cell-substance pale. In examining sections so prepared the daughter star is the prominent appearance.

ATROPHY.

Atrophy is the direct opposite of hypertrophy. Decrease of size is the constant characteristic, but not all organs which show decrease in size are atrophied. For example, there may be failure to develop, which is called *Hypoplasia.* This is well seen in chlorosis, in which there is hypoplasia of the large blood-vessels and the sexual organs. Again, in degenerations we may have decrease in size. Physiological examples of atrophy are seen in the wasting of all of the organs in advanced age, in that of the thymus gland at an early age, and of the reproductive organs of woman at the menopause. In the latter cases there is old age of the organs before that of the individual. Varieties according to cause:

senile atrophy

[illegible]

1. That due to inanition or general lack of nutrition, as in starvation.

2. That due to local diminution of blood-supply—a local inanition.

3. That due to pressure, the pressure being sufficient to diminish but not abolish blood-supply. Example: Atrophy of bone by an aneurism.

4. That due to inactivity—as in paralyzed parts.

5. That due to nervous influence. The last is most marked in diseases of the large nerve-cells in the anterior horns of the spinal cord. The proof that atrophy due to such nerve-lesions is not due to the inactivity is found in the fact that similar paralyses from brain-lesions do not cause so rapid or extensive atrophy.

Failure to develop is called Hypoplasia & the absence of an organ is aplasia.

Another classification is into (*a*) *Simple* and (*b*) *Numerical Atrophies*, the former signifying atrophy due to decrease of size of each individual cell, the latter that from decrease of the number of cells.

Morbid Anatomy. The atrophic organ is either uniformly or unevenly decreased in size, in the latter case mainly the connective tissue being involved. The color is darker, from the fact that the normal pigment is retained and is therefore relatively more abundant in the atrophic organ, and frequently also from the addition of new pigment from the blood and disintegrated albuminates. The last form is called "*Pigmented or Brown Atrophy.*" It occurs most frequently in the heart and other muscles and in the liver. The cause is chronic congestion.

DEGENERATION.

The general term **Degeneration** includes certain disintegrating pathological processes by which the cellular constituents become altered and abnormal.

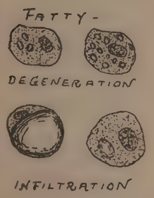
It includes :—

(*a*) *Infiltrations*, in which there is a superaddition from the blood to the cell of a substance abnormal to the cell, or a normal constituent in excessive quantity. The amyloid substance of amyloid infiltration is an abnormal substance; the fat of fatty infiltration is normal, but in excessive quantity.

(*b*) *Metamorphosis* (or *Degeneration* proper), a process in which the cell-protoplasm becomes converted into abnormal material or into excessive proportion of a normal material.

The **Infiltrations** are: *Fatty*, *Amyloid or Albuminoid*, *Pigmentary* and *Calcareous*.

FATTY INFILTRATION.



There is in this, deposition of fat from the blood in the cell.

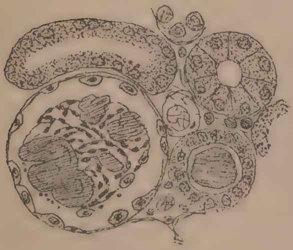
Physiological Examples. The normal deposit of fat due to the elaboration of fat or albuminates in the food. That fat of food may be directly deposited is proved by feeding starving animals with fats not found in their tissues and finding such deposited. That albuminates may be elaborated into fat is seen in cows which feed largely on albuminates and produce much butter.

Cause. The cells are either unable to use up the normal quantity of fat presented to them by the blood, or the blood is overcharged with fat and the cells cannot use it up.

Seats. Fatty infiltration occurs in cells in which fat is normal, especially in the subcutaneous areolar tissue and in the liver. Sometimes there is a general fatty infiltration, and to this is given the name *Obesity* or *Polysarcia.* The causes of this are heredity, inactivity, and excess of food. Fat is never deposited in the areolar tissue of the penis, lips, eyelids, ears, and alæ of the nose. Fatty infiltration occurs in localized areas—in the liver, intermuscular connective tissue, and about tumors and wasting organs.

Morbid Anatomy. The cells contain fat-drops which run together into one or a few and push the cell-substance and nucleus aside. If the fat is removed the protoplasm and nucleus regain their normal shape and function. Fat is soluble in ether, chloroform and alkalies. Fatty infiltration is distinguished from degeneration by the fact that the globules of oil run together, forming a large drop and pushing the protoplasm aside. In the liver, however, it is sometimes impossible to distinguish, for here the droplets do tend to run together in fatty degeneration. There is still the difference that this tendency is never so marked or so early manifested as in infiltration; and degeneration affects mainly the peripheral parts of the lobule. The part involved is also of use to distinguish fatty infiltration from fatty degeneration in the heart. Here infiltration is found in the intermuscular connective tissue, degeneration being in the muscle-fibres.

ALBUMINOID INFILTRATION.



This, which is commonly called *Amyloid Infiltration*, is an infiltration of the tissues with a substance resembling starch in that it gives a blue color with iodine and sulphuric acid. Hence the name amyloid. The name albuminoid is better, for the substance is like albumin, though it is less digestible by pepsin and less prone to putrefaction.

Synonyms. Lardaceous, Waxy or Bacony Infiltration.

Physiological Examples. Certain bodies, presenting a concentric appearance like starch-grains, and therefore called *Amylaceous Bodies*, are found normally under the ependyma and the pia mater, particularly over the medulla, and in the prostate gland. In the last situation they appear to the naked eye as grains of snuff in the substance of the gland. They are composed of cells which have undergone amyloid infiltration and then run together into concentric circles. In epilepsy and locomotor ataxia they are found in increased number. They are also found in the lung in cases of emphysema.

Seats. Connective tissue, and particularly in the intima of blood-vessels. The organs most often affected are: liver, kidney, spleen, lymph-glands and intestines—beginning in the blood-vessels of each. From the intima of the vessels the process extends to the adventitia and finally to the parenchyma. The last point is denied by many authorities, but is certainly true of the liver and probably of the kidneys. The process may be *general* or *local.* It occurs locally in the spleen, in which the Malpighian bodies alone may be involved, causing "*Sago-Spleen*"—from the appearance like droplets of boiled sago scattered in the substance of the organ—in the kidneys, in the vessels of the Malpighian tufts, in old thrombi, in scars, and in certain tumors.

Nature. The process seems to be intermediate between an infiltration and a metamorphosis. The theory has been advanced that there is formed in the blood some substance which unites with another substance in the cell to produce the albuminoid matter. The tissues affected are found poor in potassium, and phosphorus-acids, but rich in sodium and chlorides.

Cause. General amyloid infiltration occurs principally in cachectic individuals, especially in the case of long-standing tubercular or syphilitic suppurations. It is most common when there is deep-seated suppuration in bone. It has been said that the process is due to abstraction of potassium in the pus, but this is disproved by the occurrence in chronic malaria, in which there is no suppuration. When localized, it occurs only in tissues reduced below par.

Morbid Anatomy. Macroscopically, the organ is enlarged, heavy, pale, waxy or bacony, tough, and with rounded, translucent borders. The color is due partly to the nature of the substance and partly to anæmia, which is caused by the thickening of the blood-vessel walls with reduction of the lumen. A result of this anæmia is fatty degeneration, which often accompanies amyloid infiltration.

Microscopically, the most marked feature is the entire disappearance of the normal structure. Instead, there is a cloud-like or lumpy appearance, with loss of translucency of the cells. The same lumpy or cloudy contour is seen macroscopically in the small, localized areas of the process.

When localized in spots it is difficult to detect, but may be rendered more apparent by certain stains. The most commonly used is the reaction with *iodine*. If Lugol's solution diluted with twice its bulk of water be brushed over a freshly cut surface of an organ which has undergone amyloid infiltration, a mahogany-red color will be produced in the affected parts. The surface must be freshly cut. The color is readily distinguished from the greenish-brown given by iodine in the healthy parts. For microscopic testing the Lugol's solution must be made more dilute. After staining with iodine, sulphuric acid will cause a blue color like starch. The iodine reaction is also obtained with *glycogen* and *cholesterin*. Another test is the *gentian-violet* reaction, but this is used only for microscopical study. Thin sections are stained for one-half to one minute in a 5 per cent. aqueous solution of gentian-violet, then washed in a 10 per cent. to 15 per cent. solution of acetic acid and examined in this solution or in water. The amyloid portions are stained pink, the rest of the tissue blue. *Levulose* also gives this reaction.

PIGMENTARY INFILTRATION.

A deposit in the cells or intercellular substance of pigment-matter.

Synonym. Pigmentation.

Pigmentation may originate in the body (internal pigment), or from without (external or foreign pigment).

A. The *internal pigments* are derived (1) from the blood (Hæmatogenous), (2) from the bile (Hepatogenous), or (3) from albumins elaborated in the cells (Albuminogenous). The last name is not a good one, for all are derived from albuminous material.

1. Hæmatogenous Pigments.

These are derived from the coloring-matter of the blood, *hæmoglobin*. Hæmoglobin itself does not stain the tissues in health, because it is carried off as soon as it is deposited in tissues; but under pathological conditions or after death it does act as a stain. This is not uncommon at post-mortem examinations, and is seen most commonly in the large blood-vessels, especially the aorta. The tissues themselves may be stained. In life, solution of the hæmoglobin in the plasma may occur, in potash poisoning, chronic malaria, etc. This is called *Hæmoglobinæmia*. When it is excreted in the urine we speak of *Hæmoglobinuria*. Very often the hæmoglobin is acted on by sulphuretted hydrogen with the production of *sulphide of iron*. This may be seen as a bluish-green pigmentation on the intestines and liver at *post-mortem* examination.

The important hæmatogenous pigments are *hæmatoidin* and *hæmosiderin*.

Hæmatoidin is found as brownish, rhombic plates or needles; it results simply from crystallization of hæmoglobin derivatives, and contains no iron. Hæmosiderin is found as dark granules; it is a result of cell-activity, formed within living cells, and contains iron. It is probable that red corpuscles are swallowed by the cells and destroyed, hæmosiderin resulting. This process takes place in regions of chronic congestion, with brown atrophy.

Hæmatoidin and hæmosiderin are found in old blood-clots—the hæmatoidin being seen in the centre, the hæmosiderin around the circumference where there are living cells.

2. Hepatogenous Pigments.

Bilirubin is the most important. It resembles hæmatoidin in composition, containing no iron. It is found in the skin in jaundice and in gall-stones. It may be dissolved in chloroform and weak solutions of alkalies. Other bile-pigments, as *biliverdin* and *bilifuscin*, are of less importance.

3. Albuminogenous Pigments.

Melanin, the normal pigment of the skin, the choroid coat of the eye and parts of the nervous system, is the most important of these. It is granular and of brownish color; contains no iron, but usually sulphur; is bleached by chlorine, and dissolved by strong alkalies, but not by acids. It is either elaborated in the cell, or, according to some, carried to the cell by wandering cells. It may occur both in cell and intercelluar substance. Pathologically, melanin in the skin may be increased in *Addison's Disease*, a disease of the suprarenal capsules. These organs play some *role* in regulating pigmentation in the body. It is supposed by some that they elaborate a substance which, reaching the cells through the blood, there unites with the cell-protoplasm to produce melanin. In chronic malaria we find pigmentations due to melanin and to hæmosiderin. Melanin also occurs in certain tumors, particularly the sarcomata. It is seen as granules lying in the connective-tissue cells constituting the tumor. The deposit of melanin is spoken of as *Melanosis*.

Another albuminogenous pigment is *lutein*,—found in the body only in the corpus luteum. It also occurs in the yelk of eggs.

Melanosis is altered blood pigment deposited either in the plasma b. v. walls or surrounding tissue and most commonly found in malaria and is due to breaking down of r.b.c.

B. The *external pigments* gain access to the body mainly by the lungs and usually set up low-grade inflammatory changes. Coal-dust is the most common, and gives Miner's Phthisis or Anthracosis. The pigmentation here affects the lungs and bronchial lymph-glands. The pigment is not acted on by any reagent. Marble-dust causes Marble-cutter's Phthisis or Calcicosis. Iron-dust causes Grinder's Phthisis or Siderosis. Prolonged treatment with salts of silver may cause pigmentation of the skin by silver—or *Argyria.*

CALCAREOUS INFILTRATION.

A deposit in cells and intercellular substance of salts of calcium and magnesium.

Synonym. Calcification.

Physiological Example. Bone-formation or Ossification.

This differs from calcification in that there is no tendency to form the anatomy of bone in the latter.

Seat. In the intercellular substance and rarely in the cells themselves. It does occur in the large ganglionic nerve-cells. It occurs especially in (1) cartilage; (2) tumors (myoma); (3) blood-vessels (intima and media—often after chronic inflammation and fatty degeneration); (4) thrombi; (5) cheesy foci and deposits surrounded by a thick capsule, and (6) in degenerating organs of any kind.

Causes. (1) Impaired nutrition is a cause, and is seen in the case of cartilage, which has no capillaries and therefore has a poor blood supply (though here there is, besides, physiological tendency to calcification); also in myomata, in which poor circulation in the centre brings on calcareous infiltration. (2) There may be excess of limy salts in the blood, as in the case of large bone-tumors, with rapid bone-destruction. In such cases the blood is surcharged with bone-salts and widespread calcareous infiltration results. This is *Metastatic Calcification.*

Morbid Anatomy. Microscopically, calcification presents dark granules, which dissolve with effervescence in mineral acids. Macroscopically, if uniformly infiltrated, the organ may be stony; if scattered, we may see and feel spicules (especially in brain and pia), or granules, or fine grit.

METAMORPHOSES.

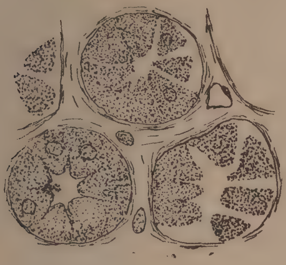
Synonyms.—Degeneration proper (this most commonly used); *Necrobiosis.*

The varieties are:

Any ~~organ~~ cell undergoing fatty infiltrat
ion or degeneration first are swollen
o the normal outline, cloudy, and then
ppear granular

(1) *Parenchymatous;* (2) *Fatty;* (3) *Colloid;* (4) *Mucoid;* and (5) *Hyaline.*

PARENCHYMATOUS METAMORPHOSIS.



An alteration of cell-protoplasm in which soluble albuminates are precipitated as fine granules of insoluble albuminates.

Synonym. Cloudy swelling.

Cause. Faulty nutrition, but especially infectious fevers. High fever alone may cause it.

Seat. Ephithelial and muscle-cells. In fevers is found widespread in such structures.

Morbid Anatomy. Organ is enlarged, grayish, cloudy, anæmic in the affected areas, and soft. Microscopically, the cells swell, grow granular—first the protoplasm, later the nucleus (the latter finally obscured)—and lose their normal outline. The granules are very minute, and resemble in appearance the fine granules of early stages of fatty degeneration, but are dissolved by acetic acid, and not by ether or alkalies.

Termination. May recover even after advanced changes. If not, more destructive metamorphoses—especially fatty—ensue.

FATTY METAMORPHOSIS.

A change of the cell-protoplasm into fat.

Physiological Example. Milk-formation.

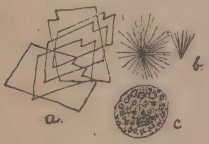
Cause. (1) Disturbed nutrition and especially decrease of oxygen. The latter is well seen in the rapid blindness from fatty degeneration of the optic nerve and posterior layer of the retina which ensues upon copious hemorrhage. Also in the fatty degeneration of the heart in chloroform narcosis. In both the cause is rapid abstraction of oxygen.

(2). Anæmia—local or general.

(3). Poisons—especially phosphorus, arsenic and iodoform. These also act by interference with oxidation.

Seats. In the cells both of the parenchyma and the connective tissue.

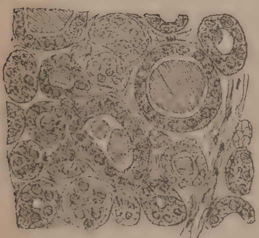
Morbid Anatomy. The organs are often reduced in size from removal of the fat (in fatty infiltration size is increased), the color is yellowish, and oil-drops may be seen on a knife which has been drawn through the organ. Microscopically, the cells become first granular as in cloudy swelling, then oil-droplets are seen, and finally the nucleus is obscured, the cells grow globular and may run together. The distinction of fatty metamorphosis from cloudy swelling is made by the acetic-acid test, the granules of cloudy swelling disappearing, and later by the appearance in fatty metamorphosis of distinct oil-droplets with brilliant centre and dark border. These oil-droplets do not run together into a large drop, as in fatty infiltration (except at times in the liver). *Osmic acid* stains fat black. A thin section is placed in a half per cent. solution of osmic acid in distilled water twelve to twenty-four hours, then washed in distilled water, and finally examined in glycerine. In some situations there appear large, fatty cells, called *compound-granule cells.* These were first discovered in the fluid of ovarian cysts. They are mainly derived from *endothelial* cells, also from *epithelial.* In tissues they are found around foci of fatty metamorphosis, and here are migratory connective-tissue cells which have ingested the oil-droplets and *debris* of the degenerated area—in other words, they act as scavengers.



(*a*) Cholesterin, (*b*) Fat-crystals, (*c*) Compound-granule cell.

Besides the above, there may be seen in fatty degeneration needle-shaped crystals of margaric acid (*probably* margaric acid—called also fat-crystals), plates of cholesterin, characterized by having a cut-out corner and by being superimposed upon each other; in late stage also spheres of leucin and needles of tyrosin.

COLLOID METAMORPHOSIS.



COLLOID METAMORPHOSIS

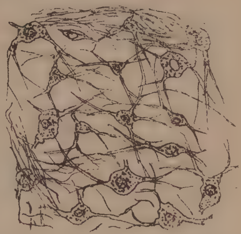
A metamorphosis of the cell-substance into a gelatinous material.

Physiological Example. Thyroid gland in advanced years.

Seat. Epithelial cells only. It occurs in the thyroid gland in one form of goitre, in certain epithelial tumors, especially cancer (colloid cancer), and in the renal epithelium, in kidney-cysts.

Morbid Anatomy. The cells show in their interiors small drops of yellowish, gelatinous material. These run together and for the most part are discharged from the cell. Accumulations result; may by pressure obliterate the epithelium, and leave only the connective tissue as a wall of a colloid cyst. Sometimes by the running together of colloid matter a concentric arrangement is produced. The colloid matter is yellowish, more firm than ordinary jelly, and is not precipitated by acetic acid or alcohol.

MYXOMATOUS METAMORPHOSIS.



A metamorphosis of the cell-protoplasm into a mucus-like substance.

Physiological Examples. Mucus-cells of mucous membranes, the vitreous humor, Wharton's jelly of the umbilical cord.

Seat. Like colloid, often affects only the epithelial cells, but may also affect connective tissue, sometimes this exclusively. Pathologically, may cause myxomatous cysts by affecting ductless mucus-glands; it occurs in connective-tissue tumors, as sarcoma, chondroma, and especially lipoma; also in ovarian cysts. It may occur as a widespread subcutaneous degeneration in the disease called *Myxœdema* or *Cachexia strumipriva.* This causes an appearance somewhat resembling dropsy, but harder and more elastic. It is most marked about the face and hands, and is caused by disease, injury or removal of the thyroid gland.

Pathological Anatomy. The cells of mucous membranes, called "goblet-cells," are physiological examples, but the same sort of cells are also seen pathologically in cyst-walls, as in ovarian cysts. In connective tissue the intercellular substance is involved, the cells being pushed far apart and finally undergoing fatty metamorphosis. The mucoid substance is lighter-colored than colloid, is more fluid, never forms concentric appearances, and is precipitated by acetic acid and alcohol.

HYALINE METAMORPHOSIS.

A change of the protoplasm into a glassy substance.

Synonym. Vitreous Metamorphosis.

Seat In connective tissue—especially in blood-vessel walls.

Pathological Anatomy. There are seen in the blood-vessels, just outside the intima, drops of glassy material, which resemble amyloid material in appearance, but do not give the reactions. There probably is also resemblance to amyloid material in chemical nature, and there is some-

Hyaline degeneration around a blood-vessel.

times actual conversion into the amyloid substance. This is recognized by the tests giving amyloid reactions in some parts, not in others. It may also occur in the adventitia of the blood-vessels, as in the brain, and as a mantle about the vessel in a tumor, called *Cylindroma*. In large, sclerosed arteries it occurs in the media and intima. As a result of the metamorphosis the artery presents a beaded appearance.

CHAPTER II.

NECROSIS.

The death of cells in the midst of living cells—a local death.

Causes. (1) Destructive—chemical or mechanical—agencies acting directly on cells; (2) obstruction of the circulation; (3) nervous influences, which may act by trophic derangement, as in bed-sores, or by causing circulatory disturbances (vaso-motor action).

Results. The necrosed part may be (*a*) absorbed; (*b*) retained, or (*c*) discharged.

(*A*). Absorption occurs by the liquefaction or breaking down and emulsification of the dead parts with absorption by the lymphatics or blood-vessels. Extensive portions may be removed in this way, and if no bacteria gain entrance, little disturbance of health results.

(*B*). Retention. The dead part becomes encapsulated by a connective-tissue capsule. It is either liquefied when we have a cyst formed, or cazeated and subsequently calcified.

(*C*). Discharge. This may be molecularly or *en masse*. The former is by a process of suppuration in which bacteria play a prominent part, the latter by gangrene, in which a line of demarkation is formed.

Replacement of the area of destruction may be by (1) cicatrization or formation of connective tissue, or (2) by regeneration or growth of tissue like the original.

The varieties of necrosis are: (1) *Coagulation Necrosis;* (2) *Cheesy Necrosis;* (3) *Liquefaction Necrosis;* and (4) *Gangrene.*

COAGULATION NECROSIS.

This is simply clotting or fibrin-formation.

Causes. (1) Bacterian, as the form due to the Diphtheria-bacillus and Tubercle-bacillus; (2) non-specific, as when it is due to shutting off of blood from a given area by embolus. Coagulation necrosis often ensues in the anæmic area (*Anæmic Infarct*).

Seats. Most common in the blood (clotting). It is common also in epithelial structures, affecting the epithelial cells themselves, and is sometimes seen in muscles and in other structures.

Pathological Anatomy. Fibrin is formed—in the blood—of three elements: fibrinogen, derived from the plasma, fibrino-plastin and a ferment from the white corpuscles and blood-plaques. In blood, the first stage of coagulation necrosis is the agglutination of the blood-plaques, or according to some (Guiteras) their formation out of white corpuscles, and possibly also the red. Next white cells adhere and fibrin is formed, often, in the blood, entangling red cells, and forming a red clot.

Microscopically, the fibrin may appear granular, homogeneous, as flakes, or as ordinary fibrillæ. Coagulation in mucous membranes is seen in diphtheria, when it gives rise to *pseudo-membrane.* In this condition fibrin is seen in the epithelial cells, on their surface, and in the sub-mucous connective tissue. It is partly absorbed and largely thrown off. Absorption is dangerous on account of the bacilli contained. Two varieties of pseudo-membrane are described: (1) Diphtheritic, an intense, deep form, with tendency to lymphatic invasion and (2) croupous, a more mild, superficial process. The former occurs by preference in the pharynx, where there is much lymphatic tissue; the latter in the larynx, where such is sparse. Coagulation necrosis is one of the earliest effects of infection by tubercle-bacilli. The bacilli enter the cells of the air-passages and set up a localized coagulation in these or in parts of them. We may see in a cell a single bacillus surrounded by an area of coagulation necrosis.

CHEESY NECROSIS.

Synonym. Cazeation.

A necrosis with formation of a cheesy material.

Varieties. Dry and moist. There may arise the one from the other. Thus the dry may become moist by liquefaction necrosis, or the moist dry by absorption of fluid. Phthisical cavities are formed by the liquefaction of dry cazeated foci.

CHEESY TUBERCLE

Pathological Anatomy. Early, evidences of coagulation necrosis;

later, fatty metamorphosis. The process is a combination of the two There is a tendency to encapsulation of the focus with subsequent calcification, or softening and cyst-formation. Microscopically, there is loss of cellular outline, the protoplasm becoming granular and opaque, and the nuclei obscured.

LIQUEFACTION NECROSIS.

A process akin to coagulation necrosis. In both the tissues are infiltrated with fluid, but in the latter coagulation takes place ; in the former never.

Examples : Blisters, variola and vaccine-vesicles, white softening of the brain.

GANGRENE.

A putrefactive fermentation of dead tissues in the living body.

Cause. Micro-organismal infection along with the general causes of necrosis.

Seats. Any structure.

Varieties. (*a*) moist ; (*b*) dry.

(*A*). **Moist Gangrene.** The more common form. The essential process in this is oxidation. As " end-products " are formed water, carbonic-acid gas, ammonium, sulphuretted hydrogen, ammonium sulphide and aromatic products. *Microscopically*, we see the products of fatty metamorphosis : fat-crystals, leucin-spheres, tyrosin-needles, triple phosphates and the rest. *Macroscopically :* A dark area, slate-colored at the centre, greenish at the periphery and dusky red around ; the area is swollen, œdematous, pits and crackles (from emphysema,—gas in the tissue) on pressure, and presents on the surface vesicles and bullæ.

(*B*). **Dry Gangrene.** Is also called *Mummification*, and is seen normally in the umbilical cord. In this form there is lack of moisture from evaporation from a break on the surface, or from absorption. The process is, therefore, slower, and the appearance that of a dry, leathery surface.

ELEMENTARY PATHOLOGICAL PROCESSES OF THE CIRCULATION.

These are certain mechanical alterations of the circulation which are factors in more complex pathological processes. We may have excess or diminution of blood in a part. The former is *Hyperæmia ;* the latter, *Local Anæmia* or *Ischæmia*. We may have either as physiological manifestations. They are pathological—(1) when the cause is an abnormal one, or (2) when the degree or duration is excessive. General excess of blood is called *Plethora*.

HYPERÆMIA.

Varieties. Active or Passive.

1. **Active Hyperæmia.** Increased flow of blood to a part. Sometimes called Arterial Hyperæmia. May be (*a*) *Idiopathic*, in which the disturbance in the blood-vessels is in the area which becomes hyperæmic; or (*b*) *Collateral*, in which the blood-vessels of the hyperæmic area are healthy, but over-filled on account of disturbance of blood-vessels and consequent anæmia elsewhere. Such is seen in the hyperæmia of one lung when circulation is impeded in the other, etc.

Causes. (1) External agencies acting on the blood-vessels; such are trauma, heat and atropia.

(2) Anatomical changes in the vessels. In inflammation there occurs fatty degeneration of the muscular coat. The same is true of infectious fevers, in which it is believed that products of micro-organismal activity act on the vessel-walls and bring about the hyperæmia.

(3) Nervous influences. This may be by stimulation of the vaso-dilator mechanism (*Neurotonic*), or by paralysis of the vaso-constrictors (*Neuroparalytic*). These nervous hyperæmias are usually reflex. Such are the extensive hyperæmias due to ovarian irritation, or that surrounding areas of irritation as necrotic masses or hemorrhagic infarcts.

Pathological Anatomy. The part is red, swollen, with increased temperature, and slightly painful. Function is increased. After death the part grows pale from contraction of the arteries, and may be paler than the healthy parts. This is especially true of the mucous membranes. If continued, hypertrophy or inflammation may ensue, or cloudy swelling, degeneration, or even necrosis.

Passive Hyperæmia. Outflow of blood prevented.

Synonyms. Stasis, Venous Hyperæmia.

Causes. There is always a general impediment to the circulation, besides the local cause of the hyperæmia. This general impediment is most frequently caused by valvular heart disease, and also by pulmonary disease. The local causes are: (1) External—such as pressure which occludes the more flexible veins, but leaves the arteries patulous; (2) disease of the veins themselves, such as inflammatory thickening of the walls, and (3) obstruction in the vein by thrombosis. These local causes are insufficient of themselves because of the ready establishment of collateral circulation in veins. Gravity also plays a part as a cause.

Pathological Anatomy. The part is of low temperature, bluish, swollen, not rarely œdematous and somewhat painful. Dependent parts of the body and the organ are affected. At post-mortem examinations the color may change to a light red, owing to entrance of air and oxidation of the hæmoglobin. The *results* are—cloudy swelling, fatty metamorphosis, atrophy (in chronic hyperæmia, brown atrophy), various other degenerations, necrosis, or even gangrene, if extensive areas are involved.

Post-mortem or **Hypostatic Congestion.** This occurs in dependent parts of the body, and is due to the contraction of the arteries after death, the blood being forced to the surface. Color, dark red or purplish. Hypostatic congestion is distinguished from areas of *ante-mortem* extravasation from trauma—(1) by pressure, which dispels the color; (2) by cutting into the area, when the blood flows from the cut, which does not occur in extravasation because the blood coagulates as soon as extravasated, and (3) by the fact that in hypostasis there is no elevation above the surface.

LOCAL ANÆMIA.

Synonym. Ischæmia.

Varieties. May be—(1) idiopathic, or (2) collateral—the terms having the same significance as in hyperæmia.

Causes. (1) Increased resistance to flow of blood in the arteries, as (*a*) by mechanical pressure, (*b*) disease of the vessel-walls, or (*c*) by obstruction within the vessel, as by thrombus; (2) nervous influences, as in the patches of anæmia and analgesia in hysteria, also the anæmia in hemicrania.

Collateral anæmia is possible, but rarer than collateral hyperæmia. It is well exemplified in the brain-anæmia due to blow on abdomen and distention of abdominal vessels.

THROMBOSIS.

Coagulation of blood within the vessels.

Causes. (*a*) Disturbance of the chemical or physical composition of the blood; (*b*) slowing of the current; (*c*) alterations in the vessel-walls. (*A*) The first element is well seen in injecting serum or various foreign fluids into the blood-vessels. Chemical alteration also occurs in extensive burns and micro-organismal infection of the blood. (*B*) Alterations of the rate of circulation act by causing a commingling of the corpuscles. Normally, the red corpuscles flow along in the centre of the stream in the blood-vessels, the white moving along close to the walls. When the current is slowed, the reds mingle with the whites, blood-plaques are formed (this being the first stage of clotting) and agglutinate (viscous metamorphosis), after which fibrin-formation proceeds. (*C*) Alterations of the vessel-wall may result from trauma or disease. Trauma may cause loosening of a few endothelial cells, which acts as a focus for clotting. Of diseases, the most important is chronic inflammation (atheroma).

Varieties. The original thrombus at the seat of the lesion is the "*Primary Thrombus*," which continues to obtain additions ("*Secondary Thrombus*") until it reaches the first branching vessel. According to shape, there are—(*a*) *Parietal Thrombi*, along the vessel-wall; (*b*) *Obstructing Thrombi*, which fill up the whole lumen; (*c*) *Valvular*, semilunar clots partly filling the lumen, and (*d*) *Channeled*, such as have suffered canalization—*i. e.*, having perforations or canals through the centre. A thrombus may change its shape at different stages, thus presenting several of the above appearances.

Pathological Anatomy. Clots vary in appearance according to the number of red corpuscles held in the meshes of the fibrin. Thus are formed dense white clots of pure fibrin, arising from white corpuscles and plaques; yellowish or "*chicken-fat*" clots containing few red cells, and soft red or "*currant-jelly*" clots. Sometimes the different varieties are seen in one clot in layers—"*stratified clot*"—due to variations in the rate of circulation during the formation.

Microscopically, fibrin appears granular, homogeneous, as flakes, or as fibres.

Seats. Thrombi occur in large and small vessels and in the heart. In the large vessels and the heart thrombi are commonly due to slowing of the circulation during the agonic period and shortly after death. These are called "*Marasmic Thrombi.*" In small vessels disease of the vessel-walls is the most common cause, especially sclerosis, with subsequent fatty degeneration.

Subsequent Changes. The thrombus may (1) *soften;* (2) *undergo calcification*, or (3) *organize.* 1. Softening occurs either by liquefaction necrosis or by suppuration. The latter is due to bacterian activity, and the broken-down parts of the clot may be swept into the circulation and carried to distant parts (as emboli), where they may set up similar destructive processes as those which occurred in the thrombus itself. If no bacteria were present, the results would be mechanical and due simply to the stoppage of the circulation in an occluded vessel. Thus we have two varieties of emboli: (*a*) mechanical, and (*b*) specific. 2. Instead of softening, other degenerative processes may occur, as fatty degeneration; and a common termination is in calcification. Thus are formed "*vein-stones*" or "*phleboliths.*" 3. Organization of thrombi very rarely occurs in the heart and the large blood-vessels. The process is similar to that of organization elsewhere, and, briefly, consists in introduction of blood-vessels and formation of connective tissue. Very commonly clots undergo contraction from shrinkage of the fibrin, and thus the red corpuscles may be squeezed out with the formation of a white from a red thrombus. The clot attaches itself to the vessel-wall, and in contracting makes the lumen of the vessel wider. Subsequently organization or softening may occur.

HEMORRHAGE.

Hemorrhage may occur as (*a*) *Arterial*; (*b*) *Venous*; (*c*) *Capillary*, *or* (*d*) *Parenchymatous*, the last being a combination of the other three. As to **locality** of origin, we have (*a*) *hemorrhage from free surfaces*, and (*b*) *hemorrhage into the tissues.*

(*A*). Hemorrhage from free surfaces.

(1) External, on the exterior of the body; (2) internal, into the large cavities of the body.

(1). External: *Epistaxis*, from the nose; *Hæmoptysis*, from the lungs; *Hæmatemesis*, from the stomach; *Hæmaturia*, in the urine; *Metorrhagia* and *Menorrhagia*, from the uterus between and during menstrual periods, respectively.

(2). Internal: *Hæmothorax*, into the pleural cavity; *Hæmopericardium*, into the pericardium; *Hæmoperitoneum*, into the peritoneal cavity; *Hæmatometra*, into the cavity of the uterus; *Hæmatocele*, into the *tunica vaginalis testis.*

(*B*). Hemorrhage into the tissues.

(*a*) May form artificial cavities, *Hæmatoma*, or (*b*) may be infiltrated in the tissues, *Extravasation.* Of the latter, an important form is ecchymosis, where the extravasation is near the surface. If the ecchymosis covers a small area, it is called a petechia; if large, suffusion. Another variety of extravasation is the "hemorrhagic infarct"—a definite extravasation area without a limiting wall, and due to embolism.

Hemorrhage is also divided according to the method of escaping from the vessel. Thus it may be by rupture of the vessel (*per rhexin*), or by diapedesis (*per diapedesim*).

Causes. (1) Traumatism; (2) excess of blood-pressure; (3) change in the vessel-walls, and (4) nervous influences.

(1). Any traumatism may cause hemorrhage.

(2). Examples are seen in the hemorrhage into the lungs and conjunctiva in whooping cough and in heart disease, especially mitral obstruction.

(3). Changes of the vessel-walls are the cause of most apoplexies (atheroma and minute aneurisms). Inflammation changes the vessel, making it brittle and easily ruptured. *Hæmophilia* occurs partly in this way and partly by alterations in the blood itself.

(4). Nervous influences are illustrated in the cases of hemorrhage in the lungs after cases of cerebral hemorrhage; also in those curious cases of bleeding from the skin called *Stigmatism.* These cases occur mainly in hysterical, cataleptic women, who at definite times bleed from parts corresponding with those wounded in the Crucifixion.

Terminations. The hemorrhage is stopped by formation of a thrombus by coagulation necrosis, and, by its subsequent organization, the vessel is securely closed. The blood, if poured into a serous cavity, is rapidly absorbed, but if extravasated in the tissues, only after some time and with considerable deposit of hæmosiderin. In the latter case, too, liquefaction and cyst-formation may occur, the fluid being at first dark, but growing finally quite clear. The final result in many cases is cicatrization.

EMBOLISM.

When a portion of a thrombus or other matter is carried in the circulation, it goes on until it reaches a vessel too small to let it pass. This is called *Embolism.* The vessel thus obstructed may be quite large, as in the case of vessels of the brain, but more often we meet with small emboli widely scattered (*Miliary Embolism*). The most frequent source of embolism is the heart, for here thrombosis is common and the blood is violently agitated. Emboli in the veins usually lodge in the lungs. Besides portions of thrombi, we may find as emboli, pieces of tissue, globules of oil or air, parts of tumors, etc. The mechanical arrangement of the circulation makes some vessels more prone to receive emboli than others. Thus the left carotid artery is more often the seat than the right; the left iliac than the right; the right pulmonary than the left. Some vessels enjoy almost complete immunity, such being the superior and inferior mesenteric arteries. The results of embolism are (*a*) *specific* and (*b*) *mechanical*.

(*A*). The *specific* results depend on the micro-organisms which are carried in the embolus from the primary focus. The result depends on the nature of the bacteria, but most commonly abscess results (*Metastatic Abscesses*).

(*B*). Of the *mechanical* results, the most prominent is

HEMORRHAGIC INFARCTION.

This is an extravasation of blood of definite shape, not surrounded by a wall, and due to embolism. When the circulation is stopped in certain arteries, the whole area of their supply becomes anæmic, and later the seat of the hemorrhagic infarction; and, as the arteries branch as does a tree, the area of infarction is conical, with the base toward the periphery of the organ. The infarct is dark-colored, somewhat elevated, and at first harder than the surrounding tissue. The shape is usually pyramidal, but sometimes, as in the brain, is irregular.

Causes. It will be necessary to consider arterial supply first. It is claimed by some that there are arteries which have no collateral circulation of any kind. These are called "*terminal arteries*" or "*end-arteries*;" but in point of fact there is no such thing, though in some parts the condition is approached, the collateral circulation being entirely capillary. It is the stoppage of such arteries that gives us hemorrhagic infarcts, and three theories are offered:

1st. It is held by some that when the embolus has lodged in an artery the area of its supply becomes anæmic, then, by collateral circulation from the capillaries, overfilling, and finally rupture occurs. The last is favored by the fact that the vessels in this anæmic area degenerate from lack of nutrition and are easily ruptured.

2d. It is contended by others that when an embolus lodges, a negative pressure results in the artery beyond this point. As a result there is a backward flow of blood from the veins, and rupture easily occurs for the same reason as stated in the first theory.

3d. Neurotic Theory. This is especially applicable to small infarcts, and certainly explains many such. It is held that the primary result of the lodgment of an embolus is a reflex contraction of the arteries and veins, the blood being forced into the capillaries, and rupture occurring in consequence.

Seats. Hemorrhagic infarcts may occur in various organs, as lungs, kidneys, spleen, and brain.

Results. If the area is small, the blood may be absorbed, or collateral circulation established and recovery ensue. Usually, however, we find necrotic changes. If the area is large, rapid necrosis occurs: liquefaction necrosis, absorption of detritus, and cicatrization. Or in some cases cysts form. It must be remembered that embolism does not always cause hemorrhagic infarcts, and in such cases slower necrosis results—a coagulation necrosis, quite different in appearance from the other, and without deposit of blood-pigments.

CHAPTER III.

COMPOSITE PATHOLOGICAL PROCESSES.

These are complicated processes, at different stages of which one or more elementary pathological processes participate. They are also termed *Proliferative Pathological Processes*, because cell-proliferation or hyperplasia is an important feature. There are three varieties: (1) **Inflammation,** and (2) **Regeneration,** which are both reactive processes—that is, they represent the reaction of the organism to insults to the tissues—and (3) **Tumor Formation,** a non-reactive, apparently purposeless process. Studied individually, inflammation is found to be always *eliminative*, tending to remove or isolate the irritant. It is therefore conservative, and even those examples usually cited by surgeons as non-conservative and destructive, such as suppuration after operation, are really conservative, having for their purpose the removal of bacteria which the surgeon allowed to get in, and which might do great damage if not removed. Again, examples, as healing by first intention, said to be non-inflammatory, and urged as proof that inflammation is unnecessary, are truly inflammatory, though of limited degree. Regeneration is a *formative* process, its purpose being repair and reconstruction. Tumor-formation is purposeless, and best called a *pseudo-formative* process.

INFLAMMATION.

Embryological Considerations. The blastoderm is divided into three layers—the epiblast, the mesoblast, and the endo or hypoblast.

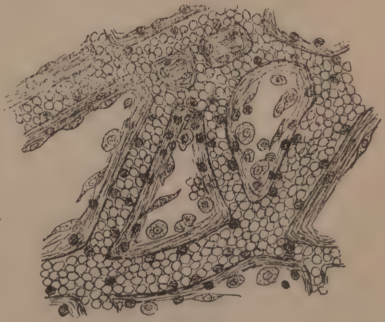
Pathological processes are sometimes studied in relation to these parts. According to His, these three are grouped under the name *Archiblast*, and there is an enveloping layer which sends in prolongations into the archiblast and eventually gives rise to the connective-tissue elements of the body, such as the fibrous tissue, the endothelial lining of blood-vessels, the blood-corpuscles themselves, etc. This layer is called the *Parablast.*

Inflammation is the group of phenomena that characterizes the reaction of the parablastic tissues to the action of an irritant, when this reaction is attended with an overfilling of the blood-vessels and the exudation and proliferation of the fluid and cellular elements for the purpose of removing or isolating the source of irritation.

The part involved is the parablast, the archiblast suffering only secondarily and through nutritive disturbances. The **irritants** which bring on these phenomena are—(1) *tissue elements* or the *products of tissue change*, and (2) *micro-organisms.* These are the things which are to be eliminated, removed. The tissue elements to be removed are such as are useless or dead.. It is hard to separate such as the original source of irritation from the micro-organisms, because the dead tissues are favorable soil for micro-organismal growth, and therefore the two are naturally associated ; and again, if bacteria are the original cause, they may act by first destroying cells, which in turn become sources of irritation. Micro-organisms are very common, but not the invariable cause of inflammation. Tissue elements become disorganized and sources of irritation from several causes, classed as (1) *external* and (2) *internal.* Of the *external* causes, trauma, chemical agencies, heat and cold are examples. These act by destroying cells, which are then sources of irritation and excite inflammation. Of the *internal*, we have those due to disturbances of (*a*) circulation, (*b*) innervation, and (*c*) metabolism. Disturbance of circulation in embolism, with resultant hemorrhagic infarction, causes dead tissue in the infarcted area, and this excites inflammation around. Almost always we see such in hemorrhagic infarction. Disturbance of innervation is illustrated in myelitis, in which trophic influences make parts unfit for use, these excite inflammation, and bed-sores result. By metabolic disturbances products irritating to the tissues result, which may degenerate, and they or else the products of faulty metabolism themselves act as sources of irritation. This is seen in the inflammation of serous membranes in Bright's disease—especially marked in the pericardium. A pneumonia may be caused in the same way in Bright's disease.

Pathological Anatomy. We study (1) changes in the blood-vessels; (2) changes in the connective tissue around the blood-vessels; (3) changes in the fixed connective-tissue elements, and (4) changes in the archiblastic elements.

Changes in Blood-Vessels. These are largely dependent on changes in the blood itself, and this depends on metabolic activity of the tissues. With degenerated, half-dead cells, the normal interchange between blood and cells and cells and blood does not occur; there results overfilling of the blood with substances intended to be discharged, the tissues are bathed in fluid not their habitual media; and, in short, there is complete change of the circulating fluid and metabolism. Then follow changes in the vessels themselves: (1) Temporary contraction of vessels; (2) dilatation of vessels and increased speed of current in arteries, capillaries and veins; (3) slowing of the current, especially at the centre of inflammation, and (4) escape of blood-corpuscles and fluid. The first contraction of vessels is very brief, and generally in studying a frog's mesentery or tongue, we first see the dilatation of vessels and speeding of the current. The subsequent slowing of the current is marked in the centre, where it may amount to stoppage—*stasis;* and in the same zone occur the most marked changes in the blood-vessel walls. At the same time, however, at the periphery increased rate of speed is still maintained. The escape of fluid and solid elements of the blood is the conspicuous and important feature. The leucocytes arrange themselves along the vessel-wall as soon as the current slows. This is explained on mechanical principles—being due to the light specific gravity of the leucocytes. Next they begin to pass through the vessel-wall in great numbers. This exudation takes place mainly on account of *alterations in the vessel-walls*, though to slight extent also from activity of the amœboid movements and increase of pressure. Coincidently there is diapedesis or outwandering of red corpuscles, though rarely in any number, and also escape of fluid. In pneumonia there is considerable



diapedesis of red corpuscles—hence the rusty sputum. Once escaped, the white corpuscles group about the vessel, so that as a typical picture of inflammation we have *large cylinders of white corpuscles, with occasionally a red one between, obscuring the vessel from view.* Later the leucocytes, by their amœboid movements, wander through the tissue and may reach the surface in ulcers as pus.

Changes in the fixed connective tissue—the parablastic tissue—go on coincidently with the outwandering of leucocytes, though in a certain sense they are secondary, being reparative in purpose, tending to build up the tissue after the leucocytes have eliminated or isolated the source of irritation. These changes then are the first step in regeneration, and are proliferative, or hyperplastic processes. At the same time, however, there are also degenerative changes. Any degeneration may occur, but fatty metamorphosis is most common. Many of the fixed connective-tissue cells also undergo liquefaction necrosis, or break down, being carried off molecularly or furnishing food for the rapidly multiplying cells in the vicinity. The evidence of the active multiplication of the connective-tissue cells is seen in the occurrence of cells showing karyokinetic changes. These hyperplastic, young connective-tissue cells are small, round cells possessed of amœboid motion and closely resemble leucocytes. They may be almost indistinguishable, but usually the young connective-tissue cell has a large, round nucleus with little protoplasm around, and some show karyokinesis, whereas the leucocyte has relatively more protoplasm and a smaller nucleus, which may be irregular in shape or multiple (not really several nuclei, but probably fragments of a degenerated nucleus); and it never undergoes karyokinesis. This appearance of young connective-tissue cells or leucocytes in the tissues is called *round-cell infiltration.* It is important to remember that adenoid tissue, normal in the submucosa of the intestines and elsewhere, resembles exactly the picture of inflammation, with accumulations of round cells and rich vascular supply; and from a single microscope field, it might be impossible to distinguish. The surroundings must be examined.

At the same time that the blood-corpuscles escape there is exudation of fluid—the inflammatory exudate. This fluid is richer in albumin and fibrin than are dropsical fluids, and the like.

Symptoms of inflammation are swelling, pain, redness and heat. The swelling is due to the increased fluid in the tissues, to proliferation of cells and overfilled vessels. The pain is due to the same causing pressure on the nerves. The redness is mainly due to hyperæmia, which also accounts for the heat—though active metabolism in the part may have something to do with this, since it was found in one experiment that the venous blood from the part was warmer than the arterial going to it. The temperature of an inflamed part does not exceed that of the blood.

Changes in the Archiblast. There is still some question whether archiblastic structures truly take part in inflammation, but in a few instances it seems impossible to exclude them. Inflammation of the archiblast is known as *Parenchymatous Inflammation.* Some authors mean by the latter only inflammation of organs, but it should not be so restricted. Archiblastic or Parenchymatous Inflammations are (*a*) *proliferative* and (*b*) *degenerative.* In the first there are cell-multiplication and karyokinetic figures, beside the exudative and proliferative changes of other inflammations. These seem certainly inflammatory. Degenerative Parenchymatous Inflammation, however, presents only degenerations in the archiblast which may occur independently of inflammation, and which here are probably only secondary to inflammation of the parablast. Of archiblastic inflammations the commonest are catarrhs. By the term **Catarrhal Inflammation** is meant a proliferative inflammation of a surface covered by archiblastic cells, as mucous membranes or the epithelial surfaces of tubular glands, as the kidneys. Examples: Catarrhal Pneumonia, Catarrhal or Desquamative Nephritis, Catarrhal Bronchitis, etc. In these cases we have multiplication of archiblastic cells and their discharge. Examination of the fluid discharged shows cells undergoing karyokinesis. In the tissue beneath, the vessels are distended and the leucocytes outwandering, for the purpose of eliminating the source of irritation. For instance, in pneumonia, the pneumococcus attacks the cells of the archiblast and destroys them, after which the leucocytes exude and help to soften, loosen and remove the dead cells, whilst proliferation of other archiblastic cells supplies the place of those removed.

Certain varieties of Catarrhal Inflammation are described:

(1). *Mucous Catarrhal Inflammation.* In this the number of "goblet-cells" becomes greatly increased, and instead of discharging their contained mucus, they are discharged bodily and are found in the fluid. Acute Bronchitis is an excellent example.

(2). *Purulent Catarrhal Inflammation.* There is in this excess of

1. Primary - Catarrhal - Regenerative - mucous surface
2. Secondary - Parenchymatous - Degeneration - Organs

parablastic involvement—a suppuration of a mucous surface. Purulent Catarrh.

(3). *Desquamative Catarrhal Inflammation.* There being no means of rapid removal of the epithelial cells, they accumulate. This is largely due to anatomical arrangement, usually occurring where the epithelium lines small tubes or cavities. Instances: In air-vesicles of the lung and renal tubules. Finally the cells are discharged.

Diffuse Catarrh is a widespread one; *Follicular Catarrh* is an inflammation of the little follicles or glands in the mucous membranes.

Besides Catarrhal Inflammation we have other archiblastic inflammations, such as in the nerves, muscles, etc., but these will be studied later.

Contrasted with the term Parenchymatous Inflammation we have Interstitial Inflammation, where the connective is involved.

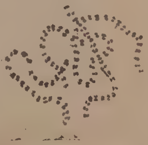
Inflammatory Exudate. This term designates both the fluid and the cellular portions. The fluid varies in nature, being (*a*) sero-fibrinous, serous, and containing flakes of fibrin which have imbibed more or less serum. Often it is jelly-like. (*b*) The exudate may be fibrinous or croupous, there being considerable fibrin-formation, as in Pneumonia or the pseudo-membrane of Diphtheria. When there is much fluid we speak of *Imflammatory Œdema*, the fluid differing from that of ordinary œdema in the greater quantity of albumin and fibrin contained.

The cellular exudation and proliferation is called variously: *Round-cell*, *small-cell*, or *inflammatory infiltration*, or *granulation tissue*, the last indicating especially aggregations of young or embryonal connective-tissue cells for the purpose of regeneration. *Inflammatory infiltration* is a term used to indicate cellular exudate which has not been absorbed or converted into connective tissue.

Suppuration. This is a special form of inflammation in which the exudation of fluid and solid elements is so intense that there is no time for regeneration. *Liquefaction necrosis* is the predominating process. The surrounding connective tissues take little active part. There is mainly exudation of leucocytes, most of which undergo fatty degeneration, as do also the fixed connective-tissue cells; and in pus we find marked evidences of this degeneration.

Cause. Spontaneous suppuration is always due to micro-organisms. It may be induced experimentally by injection of certain substances—such as tuberculin—in the absence of bacteria. The bacteria produce certain poisons which cause liquefaction necrosis, and the inflammation is for the purpose of eliminating the micro-organisms. There are a great variety of these. Of micrococci: *Staphylococcus pyogenes aureus*, *citreus* and *albus*; *Streptococcus pyogenes*, and *Micrococcus pyogenes tenuis*. Of bacilli: *Bacillus pyocyaneus*. These grow readily on the different culture media, liquefying gelatine. The term staphylococcus means a coccus which arranges itself as a bunch of grapes. This refers to the colony itself. The terms aureus, citreus and albus indicate respectively orange, lemon-yellow and white, the colors of the mass of the growth when cultivated in the air. Each separate coccus is a spherical micro-organism, devoid of color, but in mass they are yellow or white from the pigment produced around them. Streptococcus means cocci arranged as a chain—this being the microscopical arrangement—and usually the individual cocci are found in pairs. In culture it appears as a delicate pellicle. Bacillus pyocyaneus is the bacillus of blue pus. In culture it causes the medium to become bluish-green and iridescent. Of these, the staphylococcus pyogenes aureus is the most common—perhaps ten times to once of all the others. All but the streptococcus causes localized suppurations, which, however, may give rise to secondary metastatic abscesses elsewhere; but the streptococcus causes *diffuse suppuration* or purulent infiltration, which surgeons call *phlegmon*. The latter organism is very similar to the *Streptococcus of Erysipelas*, the distinctions being very slight, if any at all. Bacillus pyocyaneus is a bacillus found exclusively in suppuration. Other bacilli may occasionally cause suppuration, being more often found associated with some other process or in healthy tissues.

STAPHYLOCOCCUS.



Streptococcus.

Introduction of the bacteria into the body. Very often they enter through minute abrasions of the skin, as in rubbing, also by cuts, through the hair-follicles, etc. In case of wounds they enter on the open surface, being abundant in the air and dust of every room. In cases such as these we get local disturbances—suppuration, boils. In other cases there are deep-seated suppurations in which it is hard to make out the point of entrance of the bacteria. Such are brain and bone abscesses, and ulcerative endocarditis. In the first of these the micro-organisms perhaps enter by the nasal sinuses. A recent suggestion is that of entrance by the intestinal mucous membrane. In such cases the organisms fail to set up local trouble at the point of entrance.

The micro-organisms may remain at the point of entrance or may be carried about in the blood, setting up metastatic suppurations in various parts. This is called **Pyæmia.** On the other hand, the bacteria may elaborate certain poisons which, circulating in the body, cause disease-symptoms, mainly referable to the nervous system. This is called **Septicæmia.**

Limitation of the infective process is brought about by the eliminative action of white blood-corpuscles, by the formation of a limiting wall around the suppurating focus, and perhaps by phagocytosis. The last is a process of destruction of bacteria by the leucocytes, the latter swallowing the micro-organisms and so destroying them.

Abscess. This is a collection of pus surrounded by an organizing wall. Clinically two varieties are studied: *acute or hot*, and *chronic or cold*. The terms hot and cold signify that in the acute there is active hyperæmia with elevated temperature, whereas in the chronic there is little hyperæmia and no elevation of temperature. The classification is poor. Most of the cold abscesses are not abscesses at all, being merely broken-down, cheesy, tubercular foci, not containing pus at all. Another classification has: (1) *Idiopathic Abscesses*, those which arise at the primary point of infection, and (2) *Metastatic Abscesses*, those occurring secondarily from distribution of the micro-organisms from the primary focus.

Abscesses are surrounded by a partly organized wall, which does not break down by liquefaction necrosis, and from pus, but tends to complete organization and formation of connective tissue. Its purpose is to limit the suppuration and not to form pus, as was formerly thought, and as the name *pyogenic membrane*, by which it was known, would indicate. If it is broken through, or does not form, diffuse suppuration or purulent infiltration results. This is seen in cases due to the streptococcus pyogenes. This is called also phlegmon or phlegmonous inflammation. Usually abscesses make a way to some surface, discharge their contents and heal; but healing may not occur, in which case *fistulous tracts* result. These are sinuses or tracts from a more or less deep-seated abscess to another, to the air, or to a cavity of the body. They are walled by tissue like the pyogenic membrane. This may contribute a little pus, but very little.

Purulent Inflammation is a term designating inflammation with tendency to suppuration. There may be extension of pus-formation into the tissues, causing purulent infiltration. Sometimes there is much fibrin present, when we speak of *Fibrino-Purulent Inflammation.* This is marked in serous membranes, as the peritoneum, and presents yellowish flakes of fibrin with pus showing through.

Chronic Inflammation. This is brought about by the continuous action of the source of irritation. Thus incontinence of urine, by continuously irritating the skin of the thighs, brings about chronic inflammation of the skin ; and in similar manner continuous inhalation of irritant chemical or mechanical substances causes chronic inflammation of the air-passages. The connective tissues take the most prominent part in the process, the parenchymatous involvement being distinctly secondary. In acute inflammation the irritant must be quickly removed; in chronic inflammation this cannot occur and there is time for regeneration,—formation of connective tissue.

General Sclerosis or Fibrosis ; or, Arterio-Capillary Fibrosis (*Gull and Sutton*). This is a form of chronic inflammation the cause and nature of which are obscure. It occurs in the connective tissues, and especially the blood-vessels, in all parts of the body. The organs principally involved are the liver and kidneys, but the nervous system and other organs may be affected. It seems to be almost a distinct disease, is closely allied to Atheroma, and begins in some disturbance of circulation, being probably due to circulation of an irritant in the blood. It may be caused by continuous introduction of small quantities of certain poisons, as arsenic and chromic acid salts. The most frequent cause is alcohol. Old age predisposes to it, if it be not to a certain extent physiological in old age. Sometimes there is no poison introduced, and in these cases the irritant is probably formed in the body by imperfect elaboration of excrementitious matter.

There is, first, increase of connective-tissue formation in the blood-vessel walls, then in the tissue itself. There is prominently hyperplasia of connective-tissue cells—first, round-cell infiltration, and later formation of fibrous tissue. The sources of the increased connective tissue are :

(1). Actual inflammatory proliferation of connective tissue.

(2). Obliteration of old blood-vessels, whose walls remain and swell the bulk of the connective tissue. This obliteration occurs from pressure and when the blood-vessels become useless.

(3). Degeneration of the parenchyma. As a result of pressure the parenchyma degenerates and is removed, in consequence of which the organ is relatively richer in connective tissue. In the nervous system the degeneration of the parenchyma may be primary, giving relative increase of neuroglia—that is, the appearance of sclerosis without actual overgrowth of fibrous tissue.

(4). There may possibly be conversion of leucocytes into connective tissue, but this is very much in doubt.

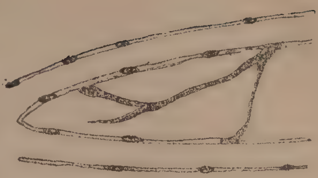
To swell the bulk of the affected organ there is often proliferation of epithelium in the midst of the proliferated connective tissue. This has been particularly studied in the liver. In the trabeculæ between the acini such increase of epithelium is found, along with increase of bile-ducts.

REGENERATION.—ORGANIZATION.

A new formation of tissue similar to the one removed. Any tissue may be regenerated, even the most specialized, as muscle or nerve-tissue. The more highly specialized the tissue the less capable of regeneration. Therefore it is most common in connective tissue. In the highly specialized tissues it is not only rare, but also hard to demonstrate. There is a limit to the possibilities of regeneration, which is approached, though not reached, in highly specialized tissues. More commonly in such tissues gaps are filled by new-formed connective tissue. Connective-tissue formation or organization may therefore be taken as a representative of regeneration in general. The important part of the process is the *formation of new blood-vessels and proliferation of fixed connective tissue.* The tissue thus formed is called Granulation Tissue. It consists of loops of new-formed blood-vessels surrounded by many round cells with little intercellular substance. It is well seen in ulcers, where it appears as numerous, fine red granules at the base of the ulcer, and from this appearance arises the name. The round cells are principally proliferated, embryonal connective-tissue cells, and, perhaps (though this is doubtful), also in a measure leucocytes. It is certain that the latter contribute to the nutrition of the connective-tissue cells by breaking down and being swallowed up. Some hold this to be the only part they play in organization.

GRANULATIONS

Formation of the New Blood-Vessels. This again is a process of cell-multiplication. One of the endothelial cells somewhere in the blood-vessel sprouts, and one of the daughter cells projects from the side of the vessel, the other remaining to take the place of the parent cell in the vessel. The outer cell goes on multiplying and finally a string of cells is formed. Next the chain of cells becomes hollowed out along the centre, and, meeting with a similar chain from a neighboring vessel, or the same at another point, fuses with it, and thus forms a new vessel. About these delicate vessels the proliferated cells arrange themselves and form the granulation tissue.



In pathological tissues this is the only method of new formation of blood-vessels. In the embryo other methods also occur.

The Proliferated Connective-Tissue Cells. There are two kinds—those which go to the formation of connective tissue, and others which degenerate, break down, and serve only for the nutrition of the former, which are recognized by their large, clear, vesicular nucleus, the difficulty with which they are stained, and the tendency to assume an oval shape. The others are known by the broken-down, fragmental nucleus, the intensity with which these stain, and the smaller and more rounded shape. It is the large, round or oval cells which form the connective tissues, and they have received the name *fibroblasts*. If bone-formation is observed, we speak of *osteoblasts*, which are large and more irregular-shaped cells. In the case of cartilage, it is *chondroblasts*. And thus any connective tissue may be formed. In granulation tissue there is little intercellular substance. Later such is formed by (*a*) splitting of the homogeneous material in which the cells had been imbedded into fibres, or (*b*) by the formation of fibrous projections at the ends of the cells, which, finally uniting with others, form a fibrous intercellular substance. Cellular proliferation and organization are beautifully studied by experimental methods. Porous substances like small pieces (one-half cu. cm.) of sponge, or dried lung-tissue or pith, are carefully sterilized and then placed in the peritoneal cavity or under the skin of frogs and other animals. They may be left here varying lengths of time, and thus the process of organization may be studied at its different stages. There soon appears congestion about the irritant, then exudation of fluid and solid elements, the former penetrating the pores quickly, the latter slowly. There is next proliferation of connective-tissue cells and formation of granulation tissue around the body. The piece may be removed at any stage, sections cut and carefully studied. In the case of lung-tissue we find this disappearing. This is due to the eliminative action of the leucocytes; but when the object cannot be thus removed, as in the case of sponge, another element comes in—viz., the "*giant cell.*" This is a large cell containing a number of vesicular nuclei, resembling those of fibroblasts, situated at one end. The cell is for purpose of elimination. There are two theories for their origin. The first teaches that the nuclei of a cell multiply, the cell not dividing at the same time; the other, that cells coalesce and thus cause the giant cell. The latter is probably true—in regeneration, at least.

Organization of Thrombi. This occurs by the same process as that we see in the case of the sponge, etc. The network of fibrin in the clot acts as a framework in which organization proceeds. New blood-vessels are produced from the small vessels in the coats of the large vessel which is occluded—that is, from the *vasa vasorum.* Nutrition of the organizing clot comes from this source, and not from the blood in the occluded vessel itself. Experimentally, in animals after twelve days numerous new blood-vessels are found in the clots.

Healing of Wounds. There is but one method of healing, and that is by organization. The clinical terms, Healing by Immediate Union, by Primary Adhesion, by First, Second and Third Intention, or under a scab, are all based on differences in the extent of inflammation involved. If little destruction of tissue has occurred and micro-organisms are excluded, we get little inflammation and healing by primary adhesion; but if micro-organisms do get in, there is much inflammatory action. The appearances in a wound after twenty-four hours are,—great redness and some swelling, exudation and glazing of the surface by lymph, a viscid fluid composed of fibrin, wandering cells and serum. Next the new blood-vessels appear, and then on the surface minute red points, the granulations. Organization proceeds as elsewhere.

Metaplasia. This is a method of connective-tissue formation different from that by embryonal tissue. It is a direct transformation of one form of connective tissue into another, as adipose to fibrous connective tissue, or bone into fibrous tissue, etc.

CHAPTER IV. see page 62

TUMORS. or Specific Inflammat

Synonyms. Neoplasms, New Growths, Pseudoplasms. "Tumors" are in the original sense swellings; but every swelling is not a tumor—as abscess, hypertrophy, etc. They are hyperplasias which present the following peculiarities:

(1). They alter the configuration of the part where they are developed.

(2). The tumor-tissue differs from that of its surroundings.

(3). The tumor-growth is persistent and progressive.

(4). They have special blood-supply, in which they resemble organs.

(5). The hyperplasia occurs without apparent cause or object.

(6). The tissue is embryonal in character.

(7). They are malignant growths.

(8). They tend to degenerate.

1. *Alteration of Configuration.* This has given the name "tumor." There may be little or great change of shape, and in accordance different names are used; as—*flat tabular swelling*—a slight elevation; *node*—a round mass; *nodule or tubercle*—a small round growth; *polyp*—a pediculated, pendulous growth; *papilloma*—a warty growth, etc., etc. Tumors have been thus classified by shape.

The shape of tumors depends on two factors: (*a*) mechanical pressure of surrounding tissue, and (*b*) the manner of growth of the tumor. They may grow centrally, when the tumor-cells alone multiply and cause a circumscribed, encapsulated node; or peripherally, when projections are sent out by the tumor, which proliferate at points distant from the tumor, or when the tissue surrounding the growth is caused to change its character.

2. *The tumor-tissue differs from that of its surroundings.* It is built on a different plan, but the same sort of tissue can always be found somewhere in the body. The tissue-elements are grouped differently from the normal tissues, or, if not, there may be slight differences in the elements themselves. The terms *heteroplasia* and *heterologous* are used to designate the fact that the tumor-tissue is out of place, but not that it is a new sort of tissue. Thus every tumor has a representative in the normal body, and on this fact is based the "*Histogenetic Classification*" of Virchow. If a tumor is made up of one

kind of tissue alone, it is called *histioid*, as sarcoma; if of several and resembling an organ, it is *organoid*, as cancer, which resembles epithelial glands; if of a number of tissues resembling a system of organs, *teratoid* or *systemoid*, as dermoid cysts, which represent the system of skin organs. Strictly speaking, no tumor is histioid.

3. *The tumor-growth is persistent and progressive.* There is apparently no limit. They grow indefinitely and may end only with the death of the patient.

4. *They have a special blood-supply, in which they resemble organs.* For example, the normal subcutaneous fat has no special blood-supply, but a lipoma has a special artery. This gives a certain independence to the tumor.

5. *The hyperplasia occurs without apparent cause or object.* This is true, as far as we know. There must be a cause, but it is not apparent, and the purpose of the growth is not evident.

6. *The tissue is embryonal in character.* The tumors most closely resemble the various tissues of embryonal life, and like the latter their marked tendency is growth.

7. *They are malignant growths.* This, like the other characteristics, is not possessed by every tumor, but does occur as a peculiar feature of some. Malignancy may be due to recurrence or metastasis. The first is a return at the original seat after removal; the latter a spread to various parts of the body. This occurs by means of the blood-vessels or lymphatics. The most benign tumor may occasionally give metastasis. A tumor may be destructive by its size and weight, but this is not malignancy.

8. *They tend to degenerate.* Degeneration is not the purpose of these growths, but here and there in all of them we find foci of degeneration, and in some cases a great deal. Still, it is rather an accidental circumstance.

Ætiology or Pathogenesis of Tumors. We do not know the causes, but there are various theories, as—

(1). That of Tumor Diathesis.
(2). The Evolutional Theory.
(3). The Mechanical Theory.
(4). The Nervous Theory.
(5). The Parasitic Theory.

1. *Tumor Diathesis* (*Billroth*). This is the oldest theory and means very little. The supporters of this theory hold to the existence

or development of some peculiarity in the fluids—the *humors*—as a result of which tumors develop; but what this peculiarity is has never been shown.

2. *The Evolutional Theory* (*Cohnheim*). According to this, tumors are really malformations or errors of development. There has occurred a faulty distribution of various elements in embryonal life, and later these grow with the formation of tumors. The cause of this subsequent growth is not stated, but certainly this theory suffices to explain the occurrence of some tumors, as *Dermoid Cysts* and some *Chondromata.* The embryonic residues of cartilage which give rise to chondromata have been demonstrated in normal bone. Certain *Mixed Tumors*, as those of the parotid gland, also support this theory.

3. *The Mechanical Theory* (*Virchow*). There are certainly tumors which have been caused by injury, blows and the like. But very often the same injuries cause no growth. There must then be some peculiarity in the person or the part of the body affected. Very often it may be shown that no injury had been inflicted.

4. *The Nervous Theory.* Doubtless trophic influences may bring about peculiar growth, but there is no positive proof of it. Many tumors are preceded by decided changes in the nerves of the part. Some tumors at least are due to this cause.

5. *Parasitic Theory.* Undoubtedly the different peculiarities of tumors can be best explained on the basis of infection, but the micro-organisms have not been found. Of course, accidental presence of one or another micro-organism may be found in the tumor as in healthy tissues. Recently much attention has been directed to the protozoa—forms of animal parasites. Some cancers show large numbers of protozoa in and between the cells.

Classification of Tumors.

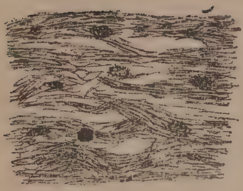
1. *Parablastomata*—Parablastic, Connective-Tissue Tumors.
2. *Archiblastomata*—Archiblastic Tumors.
3. *Teratomata*—Complicated Tumors, showing systems of organs.

Parablastomata.

FIBROMA.

This consists of fibrous tissue, and presents two varieties—(*a*) Hard, and (*b*) Soft Fibroma.

Hard Fibroma. The *type* is tendon-tissue. There is excess of fibres—the intercellular substance—and only here and there a cell. There may be an arrangement of the fibres in circles or whorls.



HARD FIBROMA.

Sometimes the intercellular substance is not fibrous, but homogeneous, as in certain Hard Fibromata of the serous membrane. The tumor is hard, often nodular and encapsulated; on section is whitish, unless its blood-vessels have become cavernous. The growth is slow, but eventually may reach a great size. In internal organs there may be but one or two; in the skin they are apt to be multiple.

Microscopically, we see fibres and scattered cells, and but few blood-vessels, unless they have become cavernous.

SOFT FIBROMA

Soft Fibroma. There are more cells and less fibres. It is really younger connective tissue. The intercellular substance often undergoes myxomatous change, which adds to the softness. The *type* is the loose connective tissue of the body. They often grow to large size, and may be lobulated like Lipomata. In the skin they are not uncommonly multiple, small and soft.

Seat. Fibromata occur wherever there is normally fibrous tissue, as in subcutaneous or intermuscular tissue, also in glands and nerves. A form not springing directly from connective tissue is the uterine Fibroma, but these are usually not pure Fibromata, being a combination of Myoma (or muscle-tumor) and Fibroma. They are common especially in colored women, and may grow to very large size.

The *Keloid Tumor* is a peculiar form of Fibroma arising in cicatricial tissue. It also is common in colored people.

Combinations. With Lipoma—Fibro-Lipoma; with Chondroma—Fibro-Chondroma; and with Sarcoma—Fibro-Sarcoma.

Degenerations. The most common is calcareous infiltration. The tumor may be nearly all lime. Fatty infiltration or metamorphosis; myxomatous change, especially in Soft Fibroma and in the skin; cavernous change; and *metaplasia* into bone, though this is rare.

The tumor is essentially benign.

MYXOMA.

Type. Vitreous humor; Wharton's jelly. Round or lobular tumors, very often encapsulated. Consistency varies according to the

degree of mucoid change. May be quite firm or so soft as to give fluctuation. On section trabeculæ are seen, and jelly-like substance in the meshes. This is precipitated by acetic acid and alcohol.

Microscopically, we see stellate cells forming a delicate network. These are widely separated by the intercellular substance, which has become mucoid. The cells themselves are healthy.

Combinations. These are frequent, as Fibro-Myxoma or Myxoma Fibrosum; Myxoma Lipomatodes, and Chondro-Myxoma. The blood-vessels may become dilated, causing Telangiectatic Myxoma. Myxo-Sarcoma is also common. In fact, all parablastic tumors may show myxomatous change.

An interesting form is *Hydatidiform Mole*, a myxomatous change in the chorion villi. The process may spread from here and attack the placenta or the uterine wall.

Myxoma may occur at any age or be congenital.

Seats. In subcutaneous tissue of back, about the umbilicus, in the cheeks, in the labia, scrotum, axilla, or in fact in any loose connective tissue. A peculiar form is that occurring in the breast. Here it may become quite large, and may be bilateral. It was formerly called *Hypertrophy* of the breast, and there is some hypertrophy, though mainly mucoid tissue. It is properly *Myxomatous Adenoma*. Myxoma may also occur in the brain and nerves.

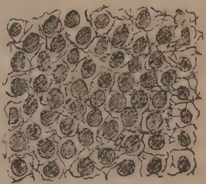
It is a benign tumor, and though metastasis has been reported, it was doubtless Myxo-Sarcoma.

It occurs very rarely in domestic animals.

GLIOMA.

Type. The neuroglia, the connective tissue of the nervous system.

Seats. Brain, nerves, suprarenal capsules; not common in the cord. Compared to other organs, it is very common in the suprarenal capsules.

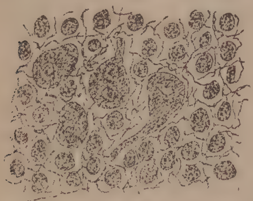


GLIOMA.

Macroscopically, it is hard to distinguish from the surrounding structures, being of much the same color as gray matter of the brain, and not distinctly outlined. It is slightly harder than the surrounding nerve-structure, and is somewhat translucent. The appearance is that of a localized area of hypertrophy or connective-tissue overgrowth making the part firm. It is usually single, and rarely larger than a fist. Growth is slow.

Nature. Benign. Does not give metastasis. A pure Glioma—Glioma of the brain—is not malignant.

Microscopically, we see a large number of cells. The intercellular substance at first looks granular, but on careful examination resolves into fine filaments. The nucleus is large and surrounded by very little protoplasm, which is prolonged into the filaments. The structure is exactly that of neuroglia. The true nerve-tissue is not present, is not hyperplastic; but there is a variety in which admixture of nerve-cells does appear. This is the *Ganglionar Glioma*, or *Neuroglioma ganglionare*, and shows, besides the ordinary elements, large nerve-cells.


NEUROGLIOMA GANGLIONARE.

Not uncommonly Gliomata are telangiectatic—that is, the blood-vessels are enlarged, angiomatous. These may break and lead to considerable hemorrhage.

Combinations. Glio-Fibroma, Glio-Myxoma, and Glio-Sarcoma.

Degenerations. Fatty and calcareous. The angiomatous may be hemorrhagic. A special form occurs in the retina. The cells resemble those of the granular layer of the retina—that is, the retinal connective tissue. These grow outward, or inward through the foramina at the back of the orbit; recur when removed, and are metastatic. They are properly Sarcomata. Glioma has never been found in the lower animals.

LIPOMA.

Type. Fat, adipose tissue.

This is one of the commonest tumors of man and the lower animals. Its structure is precisely that of adipose tissue normally, except that sometimes the cells are larger than normal fat-cells. The growth is rounded, often lobulated, well circumscribed from the surrounding tissue, and may be quite large. It is soft, and sometimes, when myxomatous change, which is not rare, has occurred, fluctuating. Growth is slow. When in loose tissue it may become polypoid, constituting *Lipoma pendulum.*

Seat. Most frequently the subcutaneous tissue. Also in the submucous tissue, as of the intestines, and the subserous, as in the peritoneum. In each of these situations *Lipoma pendulum* may occur. The *Appendices epiploicæ* are really physiological examples of such. Lipoma may also occur in the liver, the lungs and kidneys. Generally it is solitary, but may be multiple and, curiously, symmetrical on both sides of the body

Lipoma is benign, but exceptionally has given metastasis. Heredity sometimes plays a part in its occurrence.

Combinations. Fibro-Lipoma and Myxo-Lipoma.

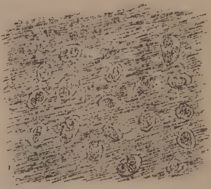
Degenerations. Myxomatous degeneration is common. It is rare not to find any spot of mucoid change. Calcification also may occur.

Lipoma is common in the lower animals, and like the normal fat it differs in appearance in different animals. In horses, the olein makes it yellow and soft, whereas the stearin in cows renders the lipoma harder and white. It is common in the subcutaneous tissue, but in the horse it often occurs in the subserous layer of the peritoneum, where it forms a pendulous tumor with a narrow pedicle. This may be twisted and broken when the tumor lies free in the abdominal cavity, and may become calcified; or by pressure, or incarceration under the pedicle, strangulation of the intestines may occur.

CHONDROMA.

Type. Cartilage.

Circumscribed, nodulated tumors, usually hard, but when they have undergone mucoid degeneration may be soft. They may grow to great size, and often are multiple, especially when about the hands and feet. Chondroma is more frequent in young persons, and sometimes congenital.


HYALINE CHONDROMA

Microscopically, two varieties may be distinguished: the hyaline and the fibrous. The hyaline are mainly those springing from bone or connected with bone; the fibrous, those arising from the soft parts. There are some distinctions from normal cartilage: (1) The cells in Chondroma may be irregular in shape, and without a capsule; (2) they may be in irregular groups, instead of regularly by twos or threes, and (3) the general arrangement of the groups may be in various directions, instead of regularly in one direction. Very often, too, marked fibrous-tissue trabeculæ are seen which are not found in normal cartilage. If these are quite marked, we speak of Fibro-Chondroma.

Seats. The skeleton—bone and cartilage; the bronchial cartilages; parotid; testicle. In the last two they are apt to be *Mixed Tumors.* These are really Sarcomata combined with other tumor-tissues, one almost always being cartilage. The origin of these in the parotid is well explained by the evolutional theory, the growth starting from remains of embryonal structures—the branchial arches. The Chondromata in bone are likewise explainable in this way, as islands of cartilage have been demonstrated in normal bone. The Chondromata of the hands and feet grow from the medulla of the phalanges.

Combinations. Myxoma, Sarcoma.

Degenerations. Myxomatous. They may also ossify—*Ossifying Chondroma.*

Chondroma is benign, but metastasis to the lungs occasionally occurs.

OSTEOMA.

Type. Bone.

Osteoma must not be confounded with certain inflammatory hypertrophies of bone. These are due very often to mechanical injuries, and would seem to support the mechanical theory; but they are not really tumors. They are known as *Hyperostoses*, *Exostoses* or *Osteophytes.* Hyperostoses is the general term, including the other two. When arborescent or dendritic in structure they are called osteophytes; when smooth, exostoses. These are commonly due to chronic inflammation, and occur particularly about the joints.

Osteomata are hard tumors, of more regular outline, slower growth and greater hardness than Chondroma. They may be arranged symmetrically, especially in young persons, and not rarely are congenital.

Histologically, two varieties are recognized:

Osteoma durum or *eburneum*, when the structure is that of compact bone, and *Osteoma spongiosum*, when the structure is cancellated.

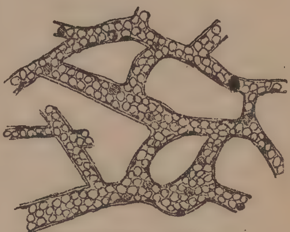
Seats. Most frequently in bone, but also in various connective tissues, as of serous membranes and the intermuscular septa; less commonly in the internal organs, as the nerve-centres and very rarely the lungs. Of the serous membranes a frequent seat is the *falx cerebri*, where we often find plates of bone in the membrane.

Osteoma is frequently multiple. It supports Cohnheim's embryonal theory. It is benign.

In animals Osteoma is not rare, and occurs in the same situations as in man. In horses a frequent seat is along the lower border of the lower jaw. *Spavin* is a name applied to exostoses in animals.

ANGIOMA.

Type. Blood-vessel tissue.


TELEANGIECTATIC ANGIOMA.

This is a form of vascular tumor, often called *erectile*. There are two kinds: (*a*) telangiectatic and (*b*) cavernous.

(*A*). In the telangiectatic there are found dilated but well-formed arteries and capillaries, with walls as in normal blood-vessels. They occur on the surface of the body as *mothers' marks*, *nævi*, etc. Sometimes they are seen in internal organs, in bone and the brain.

(*B*). The cavernous present cavities within connective tissue lined with endothelial cells. It is similar to the erectile tissue of the penis. This form is most frequent in the liver of old people, and rarely occurs in spleen and kidney. These are small, well-circumscribed tumors, not raised above the surface. They are rarely larger than an egg.

Combinations. Angio-Fibroma, Lipoma and Sarcoma. Very frequently it may be merely angiomatous change in previously existing tumors.

LYMPHANGIOMA.

Dilatation of lymph-spaces and vessels constitutes a tumor called Lymphangioma. This is most frequently *telangiectatic*—that is, due to dilatation of the vessels—and not cavernous, with formation of large cavities. It is often congenital, especially about the tongue and lips. The former causes a uniform enlargement of the tongue which grows still larger after birth, and is known as *Makroglossia*. It is a common feature in *Cretinism*. Similar condition of the lips and cheek is called *Makrocheilia*. Lymphangioma is also met with in Elephantiasis. Here there is no true tumor, but merely a dilatation of the lymphatics from obstruction, as by the *Filaria sanguinis hominis*. This condition involves mainly the lower extremities and external genitalia (scrotum and labia).

Lymphangioma hardly ever occurs in animals.

LYMPHOMA.

Type. Lymphatic Gland.

These may be defined as tumors having the structure and arrangement of lymphatic glands.

Most of the so-called lymphomata are not tumors, but merely hyperplasias, functional enlargements from overwork. This, of course, is opposed to our ideas of tumors.

There have been classified under this head:

1. The lymphatic enlargement in *Leukæmia*. This enlargement not only affects the glands, but is also found in organs like the liver, where we see no lymphatic foci normally. It is almost certainly due to irritation—probably infection.

2. Tubercular and syphilitic enlargements of the lymph-glands. These belong to the specific inflammations.

3. Glandular enlargements following irritation, as in enlargement of the cervical glands from irritation in the mouth.

In the above there is well-marked *cause*, and they are not properly, therefore, tumors; but in the following there is no obvious cause or object, and we must regard these as true tumors:

4. In Hodgkin's disease there is enlargement of the glands with no visible cause and preserving the normal structure. This is properly called *Lymphadenoma*.

5. When we have such causeless enlargement with structure resembling Sarcoma, *Lympho-Sarcoma* is the proper name.

6. There is a peculiar form of Lymphoma in the mucous membrane of some of the lower animals, which appears as a well-circumscribed lymphatic tumor in the mucous membrane of the uterus and true stomach of ruminants.

SARCOMA.

Type. Granulation tissue; embryonal connective tissue. In regeneration of connective tissue we saw first round cells with large nuclei, later spindle cells, finally fully formed connective-tissue cells, perhaps giant cells with several large nuclei and intercellular substance. Sarcoma presents some one of the stages short of the formation of new tissue with intercellular substance, and an arrest at that stage. It may be defined as embryonal connective tissue which fails to assume any of the types of fully formed connective tissue. *Histologically*, it may be defined as a connective-tissue tumor in which the cells so predominate in number and size that the intercellular substance becomes the subordinate element. Sometimes there is some formation of fully developed connective tissue in Sarcomata, but this is rare and occurs only here and there in isolated spots.

Origin and Growth. They arise from previously healthy connective tissue (which is most common), or from connective tissue already proliferating, either in the process of inflammation or the formation of some simple connective-tissue tumor, which then takes on sarcomatous change. Growth occurs by multiplication of the sarcoma-cells themselves or by metaplasia—*i. e.*, change of the surrounding structures into sarcoma-tissue. Growth is comparatively rapid and causes a characteristic appearance, that of a well-circumscribed tumor, though sometimes we find growth by infiltration, as in cancer. This rapid growth brings with it richness in blood-vessels, which are large and do not present distinct walls, there being no formation of adult endothelial cells, etc.

The *consistency* and *color* depend on the richness in cells and the modifications in the intercellular substance. Mucoid change in the intercellular substance may render the tumor soft, while a sarcoma in bone may be quite hard.

Seats. **Primary Sarcoma** may occur wherever there is connective tissue. The most frequent seats are: the skin and subcutaneous tissue, the intermuscular septa, tendons, subserous connective tissue, the eye, and the periosteum of long bones; less frequently in the interior of bone, in lymph-glands and in the membranes of the brain and cord; it is uncommon in the mucous membranes, especially of the uterus, in the lungs, kidneys, liver and the brain.

Sarcoma arises in persons between twenty and forty years old.

Causes. The mechanical theory is very applicable in some cases—more so than in the case of cancer—but there always remains the fact that a more important predisposing cause must have preceded the trauma. Sarcomata are often congenital.

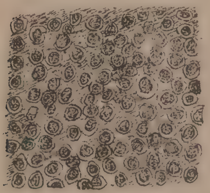
Malignancy. Recurrence and metastasis occur, the latter along the blood-vessels. This is known from the fact that neighboring lymph-glands are not involved, and has been *directly* proved by finding a sarcomatous growth extending into a blood-vessel, discharging parts of its structure into the blood and thus causing secondary growths. It is thus that the general deposit of small sarcoma-foci all over the body occurs—*Miliary Sarcomatosis.* The principal seats of

Secondary Sarcoma are the liver, lungs and heart. *Malignancy is greater in the soft varieties and in those containing large numbers of cells*, but sometimes changes in the intercellular substance may make the tumor soft or hard without affecting malignancy. Thus myxo-sarcoma may be quite soft, yet more benign than the hard osteo-sarcoma. The most metastatic sarcomata are the round-celled and pigmented varieties. Those at the periphery of an organ are more malignant than deeply seated ones, probably because they are nearer large blood-supply. Thus sarcoma of the periosteum is more malignant than one of the interior of the bone.

Degenerations. Fatty degeneration, calcareous infiltration and ossification may occur. The last represents development of fully formed connective tissue, and is a rare occurrence, being generally found only here and there in spots. The tumor may break down and ulcerate, but much less commonly than in cancer. In fact, this is generally a distinction between the two. The growth may become inflamed and produce fungoid masses. Cyst-formation also occurs, either by softening (softening cysts) or by pressure on ducts, causing retention-cysts. These form the *Adeno-Sarcomata* or *Cysto-Sarcomata* of the breast. Extravasation-cysts are also met with. Teleangiectatic condition of the blood-vessels is not rare. It is often accompanied by thrombosis and hemorrhagic infarction.

Varieties. These depend on the stage to which the development of the embryonal tissue has progressed, and on certain degenerations.

ROUND-CELLED SARCOMATA. These grow rapidly, even for sarcomata; are soft, whitish and somewhat translucent. On pressure a milky fluid may exude. This occurs only now and again, and is not seen until some hours after removal, whereas in cancer it is common and seen immediately after removal.



SMALL R: CELLED SARCOMA.

Microscopically, we see the appearance of a round-celled infiltration, with slight amount of intercellular substance, which is homogeneous, presenting here and there a little fibrillar material. The intercellular substance is conspicuous by its absence to cursory examination.

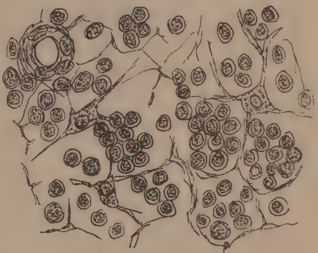
Varieties. Small and Large Round-Celled Sarcoma, and Lympho-Sarcoma.

Small Round-Celled Sarcoma. The cells in this variety are small round cells with large nuclei almost filling the cell. They are very malignant.

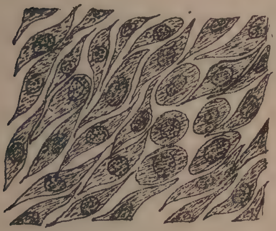
Large Round-Celled Sarcoma differs from the last in having larger cells, in being harder and less malignant.

Seat. Both forms occur in the connective tissue of the skeleton, the muscular fibres, subcutaneous and dermal tissues, in the testicle and the ovaries.

Lympho-Sarcoma is a form of small round-celled sarcoma in which groups of the round cells are separated by a reticulum formed by the prolongations of certain stellate cells. The structure resembles that of lymph-glands. These are found mostly in lymphatic structures, and are quite malignant.


LYMPHO-SARCOMA.

SPINDLE-CELLED SARCOMATA.

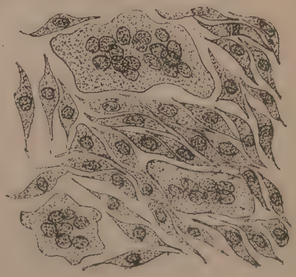

LARGE S-CELLED SARCOMA

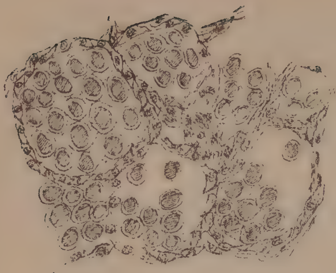
These have the appearance of flesh. They are harder than the round-celled, are more yellowish in color, and do not exude milky fluid. The cells are apt to run in certain directions in bundles, and this appearance is presented even to the naked eye. There are two *varieties*—those with large (see fig.) and those with small cells, in both of which the nuclei, as in all sarcomata, are noticeably large. These are generally benign, though they do recur after removal, and have therefore been called "recurrent fibroids." Fibrous overgrowth is not rare, and constitutes *Fibro-Sarcoma.*

Seats. Periosteum, subcutaneous connective tissue, the connective tissue of the mammary gland, the muscles and intermuscular septa and the intestines.

POLYMORPHOUS SARCOMATA. In these there occur various-shaped cells and often also giant cells, then constituting:

Giant-Celled Sarcoma. This occurs most frequently in bone, particularly about the jaws, in which situation it receives the name *Epulis.* The giant cell, which occurs normally in the medulla of bone, is the characteristic feature. These are comparatively benign tumors. Recurrence may be met with, but rarely metastasis.

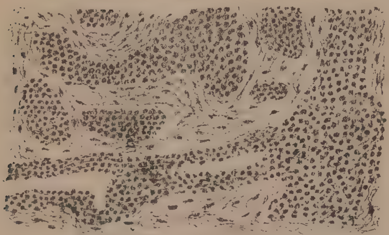




ALVEOLAR SARCOMA

Alveolar Sarcoma. This form resembles cancer very closely in some respects, and is considered as cancer by some authorities. It presents alveolar spaces of connective tissue filled with cells. These nests differ from those in cancer in that the trabeculæ are not formed of fully developed connective tissue, being rather composed of spindle-cells (see fig.). The alveoli may, however, be produced by the development of sarcoma-cells in the meshes of previously formed connective tissue and pushing this aside. In this case the resemblance to cancer is very close, but in the latter we find epithelial cells, while in sarcoma we see connective-tissue cells. Finally the alveoli may be developed by the formation of perivascular sarcoma, in which sarcoma-cells about blood-vessels multiply until the interspaces between adjoining vessels are full, when the blood-vessel walls become boundaries of alveoli full of cells.

Seats. Skin, bone, lymphatic structures and the membranes of the brain, especially the *pia.* In the skin they usually spring from warts.



ENDOTHELIOMA.

Endothelioma. This is a variety of sarcoma formed by the multiplication of the endothelial cells lining lymph-passages. In consequence they branch and ramify in all directions. They are most frequently seen in serous membranes, where they spread widely.

Melanotic Sarcoma. Any sarcoma, but especially the round and spindle-celled, may become melanotic. The only difference from other sarcomata is the pigmentation. This may be diffuse or granular, in the tumor-cells themselves or in the intercellular substance which may happen to be present. The pigment is melanin.

Seats. Wherever pigment normally occurs: the eye, the skin, the *pia mater.*

MELANO-SARCOMA.

Metastasis is a marked feature, the secondary growths being also melanotic and often darker than the primary. Curiously, metastasis very commonly occurs to the digestive tract. A melano-sarcoma of the eye nearly always gives some metastasis to the liver.

Pigmented warts, moles and the like are not rarely the starting-point of melanotic sarcoma.

Chloroma. This is a form of round-celled sarcoma found only in the periosteum of the skull. It is of a greenish color, probably from fatty degeneration.

Psammoma. This is generally a sarcomatous tumor, showing calcareous infiltration, with formation of certain small, concentric bodies. It occurs in the membranes of the brain, especially the choroid plexus.

Combinations of Sarcoma. Fibro-, Glio-, Chondro-, Osteo- and Myxo-Sarcoma. The last is called *Cylindroma.*

Cylindroma. *Macroscopically*, cylinders of gelatinous tissue are seen running in all directions through the tumor. Very often it is merely myxomatous change in the centre of a sarcoma; but there is another way in which cylindroma may arise—similar to one form of alveolar sarcoma. In this the walls of the vessels and surrounding connective tissue undergo hyaline degeneration, and we see a constricted blood-vessel with a mass of hyaline material around it. Later a mantle of sarcoma-cells develops around all. This form has received the name *Angio-Sarcoma Myxomatodes.*

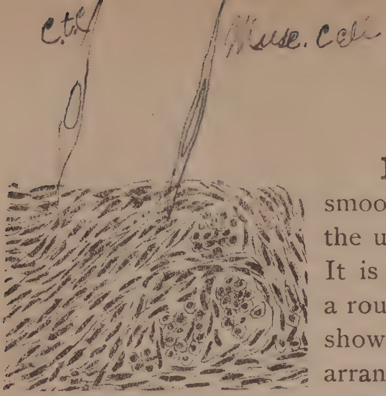
Sarcoma in Animals. Sarcoma is common in horses and dogs, rare in horned cattle. Melanotic sarcoma is the most interesting form. It occurs quite often in horses, and especially gray or white ones. It is found about the anus, vulva or prepuce, is soft, and gives general metastasis. Another form is harder and tends to remain local.

ARCHIBLASTOMATA.

These are tumors representing in their structure the tissues of the archiblast of His—that is, the so-called parenchymatous elements.

MYOMA.

The *type* of myoma is muscle-tissue. There are two varieties: Leiomyoma and Rhabdomyoma.



LEIOMYOMA

Leiomyoma. The type of this is smooth, muscular fibres, such as occur in the uterus and other involuntary muscles. It is very common. *Macroscopically*, it is a rounded, well-circumscribed, hard tumor, showing on the cut section a fibrous arrangement very like fibroma, with which, indeed, it is commonly combined, especially in the uterus. *Microscopically*, leiomyoma is composed of spindle-shaped cells containing large, rod-shaped nuclei. The cells are seen to run as fibres in different directions, and when viewed in cross-section appear like round cells with large round nuclei. The growth of leiomyoma is quite slow, but it often becomes very large. It occurs especially in the uterus, œsophagus, intestine and prostate. It is very prone to undergo calcification, particularly the uterine fibro-myomata. Again it may soften in the centre (softening cyst) or become cavernous. In the lower animals it occurs in the same situation as in man.

Rhabdomyoma. *Type.* Striated muscle. Error of development is an evident factor in the occurrence of these tumors. They are found especially in the segmented organs of the embryo—the kidneys, ovaries and testicles—where doubtless a little muscle-tissue might have been left. Rhabdomyoma is often congenital. *Microscopically*, we find striated muscular fibres, which, however, are often undeveloped, being spindle-shaped instead of long fibres. Usually there is considerable sarcoma-tissue combined, and to this fact is due the malignancy of the growth and metastasis.

They may become quite large. A form of *pure rhabdomyoma* is found, rarely in the muscles, especially the heart, as small nodules. Its occurrence cannot be explained so readily as that of the other form.

NEUROMA.

The *type* is nerve-fibres.

Varieties. True and false.

False neuroma is the common variety, and is merely a fibroma growing on a nerve. Not rarely these are multiple and may follow the course of the nerves, giving the appearance of a series of anastomosing and branching cords or ridges. They are most frequently seen in the cutaneous nerves.

True neuroma may occasionally occur in much the same way—

that is, in the continuity of nerves—but the commonest form is that at the end of a nerve in stumps. Here we find growth of fibres springing from the cut end of the nerve.

Microscopically, we see in true neuroma only proliferated nerve-fibres, never cells. Proliferated nerve-cells constitute the tumor called *ganglionar neuro-glioma.* There are two kinds of true neuromata, the medullated or myelinic and the non-medullated or amyelinic. The latter consists of gray nerve-fibres.

3d form is a plexiform of the nerve: Thickening of a vast no. of nerves.

EPITHELIAL TUMORS.

These, while containing mainly epithelium, also have more or less connective tissue, which is necessary as a skeleton or framework and carries the blood-vessels to furnish nutrition. Therefore there is some connective-tissue hyperplasia besides the essential epithelial proliferation.

We distinguish two varieties: (1) *Simple Epithelial Tumors* and (2) *Carcinomata.*

1. SIMPLE EPITHELIAL TUMORS.

These are of two kinds: (*a*) *Polypoid* and (*b*) *Adenomata.*

POLYPOID OR PAPILLOMATOUS EPITHELIAL TUMORS

The type of these tumors is the papillæ of the skin. Very often these growths are not truly tumors, but results of chronic inflammation. If there is slight and superficial hypertrophy of the skin, we get the projections called corns or *clavus;* when there is very excessive hyperplasia of the epidermis there occur prominent outgrowths called horns or *cornu cutaneum.* Elephantiasis may also be classed among these simple epithelial growths, though in this the subcutaneous connective tissue takes an important part, whereas in the other forms the epithelium is predominant. *Condyloma* is also a form in which the connective tissue is important, growing upward and branching, but always carrying on its surface a lining of epithelium. It is of inflammatory origin.

PAPILLOMA.

This is the nearest approach to a true tumor, being generally due to no evident cause. It stands midway between the previously-mentioned inflammatory growths and the true, causeless tumors. Here we also find connective tissue in the interior, but this follows secondarily after the proliferating epithelium. Two varieties are usually described—viz., the *hard* and *soft.* In the former the connective-tissue framework is denser and there are fewer cells than in the latter. The hard grows mainly from the skin; the soft from the mucous membranes, especially the bladder, rectum and uterus.

The above forms are characterized by upward or outward growth, in distinction from adenoma and cancer, in which growth is inward or downward.

ADENOMA.

House with rooms in the yard & orchard.

Type. Glandular tisssue—*i. e.*, connective-tissue sacs lined with epithelial cells. In adenoma this same relation is observed, but the tumor differs from the gland, in that there is not the normal relation of the various pouches to each other and to excretory channels. In other words, in adenoma there is constant formation of pouches of normal structure, but never the arrangement of a normal gland. The appearance of an adenoma, then, is that of epithelial cells resting on a basement-membrane, the cells retaining more or less the characteristics of those of the gland in which the tumor occurs.

Seats. Adenomata develop in glandular structures, as the liver, kidneys, mammæ, thyroid, etc.; also from the small glands of mucous membranes and skin. Those occurring in large glands are rounded, well-circumscribed, often encapsulated tumors, and are benign; those in mucous membranes are flat, irregular-shaped and spreading growths, which are apt to become malignant by the epithelial cells breaking through the basement-membrane, proliferating and assuming cancerous properties. This last is not rare in adenoma of the uterus.

Varieties. Tubular, acinous or racemose, according to the gland represented.

Distinctions from Cancer. We see no abnormality of histological structure in adenoma, but only disturbance of *general* structure of the organ. The force which directs the formation of organs is, therefore, at fault. In cancer, however, the histological structure itself is atypical. If there is a basement-membrane, the epithelial cells are found to have broken through and multiplied outside, with production of new "nests." There is formation of connective tissue around these new nests, which in turn is broken through, and thus epithelial hyperplasia continues, together with proliferation of connective tissue for the purpose of surrounding and limiting the process. Evidence of the active connective-tissue proliferation is seen in the round-celled infiltration about the cancer-foci. Another distinction of adenoma from cancer is, that while in the former the epithelial cells largely, though not entirely, retain the characters of those of the gland in which the tumor occurs, cancer-cells lose these characters largely, though never completely.

CARCINOMA.

This is an epithelial tumor atypical *histologically*. It is usually called cancer.

Microscopical Structure. As above described, we find, instead of regular arrangement of the cells on the basement-membrane, breaking out and further growth of the tumor by constant infiltration of the surrounding tissue. The cells are epithelial and usually quite altered from the appearance of those normal to the part involved. Careful search is sometimes necessary to find cells of shape normal to the part, but this is always possible, especially about the periphery of the nests. The cells are large, with relatively small nuclei, which are pale and vesicular. The shape of the cells depends (1) on the locality in which the tumor occurs, and (2) upon the mutual pressure. In the centre of the nest are usually seen large, polyhedral cells of various shapes. These were formerly regarded as specific cells of cancer and called *polymorphous cancer-cells.* There is, however, nothing distinctive about them. Cancers of the skin present cells more or less resembling the deep epidermic cells—the cuboidal; those of glandular organs more or less the cells of the gland. There is, besides this general resemblance of shape, also resemblance in physiological tendencies—that is, the tumor-cells tend to undergo the same degenerative changes as the epithelial cells normal to the part. Thus the cells of skin-cancers, like normal epidermal cells, tend to undergo *horny change*, those in cancer of the breast *fatty degeneration*, and in cancer of the mucous membrane *myxomatous change*.

Macroscopy. Primary cancers appear as hard, irregular tumors which grow mainly by infiltration, and are therefore not encapsulated. They grow (1) from epithelial surfaces, when they are often papillomatous, or (2) in glands, when they appear as deep-seated masses. Growth is slow. Secondary carcinomata are rounded and encapsulated, and grow much more rapidly than the primary.

Seats. Primary cancer (in order of frequency): the vaginal portion of uterus, skin, mammary gland of female, pylorus, rectum, œsophagus, ovaries, testicle, external genitalia, prostate, bladder, pancreas, kidneys, small intestines, thyroid, bile-ducts, liver and bronchial tubes.

Age. Skin and intestinal cancers occur after forty, uterine between thirty and forty, those of the internal sexual organs early, and sometimes congenitally.

Metastasis. This is effected—(1) by infiltration of surrounding tissues, (2) by spreading along the lymph-channels, (3) along blood-vessels, (4) by growth along surfaces, as in the peritoneum. It is the cells of the cancer themselves that are carried from place to place. Such have been demonstrated in occluded blood-vessels and even in the blood itself. Secondary growth is first seen in the lymph-glands adjacent; then come (in order of frequency) liver, lungs, peritoneum, pleura, spleen, kidney and skeleton. Cartilage escapes involvement. A peculiar feature is sometimes seen in the metastasis from cancers of the breast—that they produce secondary growths in the skeleton only. This is a rare occurrence. Metastasis by the blood-vessels is seen especially in the portal circulation.

Duration. The usual course is chronic and of about one year's duration, but sometimes rapid spread is observed, especially in the peritoneum, from cancer of the stomach or ovaries. This proves rapidly fatal, and is called *acute carcinosis.* Occasionally the growth may be temporarily hastened, as in cancer of the breast or uterus during pregnancy.

Effect on Health. Cancer is exhausting. This may be due to micro-organismal infection, causing suppuration, pyæmia or septicæmia; to the interference with healthy action of the organ involved; to hemorrhage; and perhaps (though this is not proved) to the production of some special and debilitating poison.

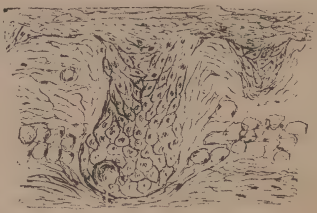
Degenerations. These may involve the epithelial cells or the connective tissue. The changes in the former depend partly on the location of the cancer, as above described. Thus we find horny change, fatty and mucoid degeneration in the epithelial cells. Not rarely, especially in surface-cancers, ulceration occurs, with formation of crater-like excavations. Bacterian infection has much to do with this.

In such areas we may find normal granulation-tissue, with subsequent formation of papillomatous outgrowths or connective tissue. Ulceration into large blood-vessels may cause hemorrhage. Calcareous and pigmentary infiltration are rare. Colloid degeneration may occur, as also cyst-formation.

Combinations. With adenoma and other simple epithelial growths.

The *varieties* are as follows:

Squamous Cancer. This tumor, usually called *squamous epithelioma*, is found in surfaces covered by squamous cells, especially in the skin near borders of mucous membranes, but also in certain mucous membranes covered by squamous cells. The lips, nose, eyelids and *glans penis* are frequent seats; and of mucous membranes, those of the vaginal portion of the uterus, the mouth, pharynx, œsophagus, bladder and larynx all give rise to it.



SQUAMOUS EPITHELIOMA.

Irritation plays some part as a cause, as we see in pipe-smoker's cancer of the lip. grow slowly. Followed by a slow ulcerative process

Squamous cancer first appears as a warty tumor which tends to infiltrate and produce a flat swelling. On section it is seen to be a juicy tumor, from which small droplets of whitish, milky thick fluid exude. This is merely a secretion of the epithelial cells squeezed out of the alveoli.

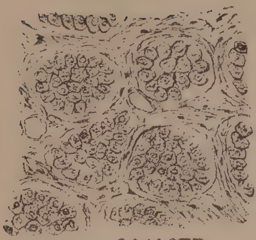
* *Microscopically*, it shows the cuboidal cells characteristic of the deeper layers of the skin. These tend to become horny and squamous, toward the centre and to be arranged in concentric whorls (pearly bodies).

Cylindrical Cancer. This is usually called *cylindrical epithelioma*. It is composed of cylindrical cells, and is found in mucous membranes, especially in the intestines, where it is a common form. It is apt to be soft, somewhat papillomatous and spread out on the surface. In the large glands it is more circular and appears as white nodules.

Glandular cancers are such as grow from glands, and represent more or less glandular structure. Several varieties are described:

Simple Glandular Cancer. This might be considered a normal or type-form, in that a certain relation of cells to connective tissue is maintained without excess of either element, and it is of medium consistency. The seats are (in order of frequency): mammary gland, liver, salivary glands and pancreas.

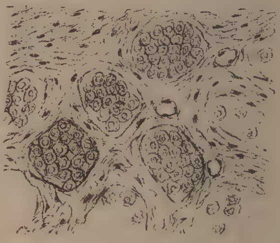
* arise where ever there is flat epithel cells.



SOFT CANCER

Medullary Cancer. Soft cancer. This is distinguished by its brain-like consistency, the large number of cells and lack of connective tissue. It is softer, more juicy and more malignant than the last form. The softness is due to the number of cells and to degeneration, especially fatty. Seats: Mucous membranes, ovaries and testicle.

Scirrhus. Hard Cancer. Excess of connective tissue renders the cancer hard. It occurs especially in the mammary gland and at the pylorus.



HARD CANCER

Colloid Cancer. This name is misleading, for most "colloid" cancers are myxomatous, though some are truly colloid. It occurs in the digestive tract and in the ovaries. The appearance presented is that of trabeculæ of connective tissue enclosing gelatinous material. The mucoid degeneration usually involves the cells, giving the ordinary *gelatiniform or colloid cancer.* Sometimes, however, the connective tissue alone is involved—*carcinoma myxomatodes.* This is rare, and sometimes resembles the form of sarcoma called *cylindroma.* True *colloid* cancer is still more rare. These colloid cancers are less malignant than the forms from which they are derived, being less metastatic.

Melanotic and **Giant-cell Carcinomata** are rare.

Cholesteatoma. These are epithelial tumors which occur in the brain and meninges, and belong properly to the *teratomata,* as may be inferred from the occurrence in them of sebaceous glands, hair-follicles and other dermal structures. *Microscopically*, they present peculiar whorls of cells arranged concentrically and enclosing cholesterine-plates.

Cancer in the Lower Animals. The dog is the most commonly affected animal. Cancer is rare in vegetable-eaters. Curiously, the uterus is a rare seat in animals, the mammary gland being the commonest seat, especially in the dog. In horses the skin about the external genitals is a frequent seat. and intestinal canal

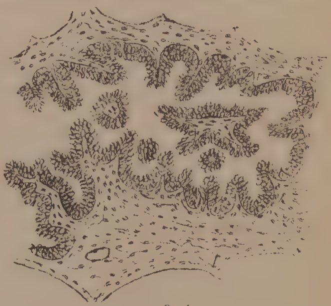
CYSTS.

We exclude the distinctly non-tumorous cysts, such as *extravasation cysts*, which result from hemorrhage with subsequent absorption of the clot and extravasation of serum into the area; *softening cysts*, which result from localized degenerations and liquefaction; and *parasitic cysts*, like the hydatid. A common seat of softening cysts is the brain, where they result from embolic processes, or (mixed with extravasation cyst) from hemorrhage. We describe as true tumorous cysts, *retention cysts* and *proliferative cysts.*

Retention-Cysts. These are produced by obstruction to the outlet of glands. They may be small, when they are called *follicular*, as in the sebaceous cysts, comedo and atheroma, small cysts of the skin-glands. Those in which there is retention of mucous secretion are called *mucoid cysts*. Retention [illegible] Such are seen in the mucous membrane of the * *cervix uteri*, also in the nose, where they may be quite large from obstruction of the large sinuses.

Retention cysts also occur in organs as the liver, kidneys, and salivary glands. In the last situation the tumor is called *ranula.* Not all are due to obstruction of glands

Proliferative Cysts. These are more frequent in the mammary gland and the ovary than elsewhere. In the interior of a cyst lined with epithelium, which probably began as a retention-cyst, we may get all the changes seen in epithelium elsewhere. Thus we may find a papillomatous growth, constituting *cystoma papilliferum.* There may be interminable doubling of the epithelial surfaces with formation of small cysts, which is called *cystic adenoma.* Finally the epithelial cells may break through the basement-membrane and give rise to cancer. In all of these forms there is active proliferation of epithelium, hence the name *proliferative.* The folding of the epithelial surface is more marked in the ovary than in the mammary gland. Whenever we find a proliferative cyst which is papilliferous, especially if in the ovary, suspicion should arise; for not uncommonly cancerous change occurs, and in the case of the ovary extension into the peritoneal cavity.


PAPILLIFEROUS ADENO CYSTOMA

Two forms of cysts occur in the region of the ovary. One is *multilocular*—that is, composed of many small cysts—and springs from the ovary; the other, *unilocular*, and is truly a retention-cyst of the parovarium—a remnant of fœtal structure which exists in the adult as a duct lined with epithelium.

TERATOMATA

Same as

Dermoid Cysts. These errors of development are most frequently met with in the "segmented organs." They are cystic tumors, representing the system of dermal structures: hair, nails, skin, teeth, etc., etc. They are the strongest proof of Cohnheim's Embryonal Theory, being readily seen to be developed from epiblastic remnants left in improper places, where they finally grow.

Due to errors of development.

CHAPTER IV.

INFECTIOUS GRANULOMATA.

We consider under this head certain forms of infectious diseases, which, from the fact that they may involve any structure, must come into the study of General Pathology. These processes have been variously named infectious granulation tumors, specific inflammations and granulomata (Virchow). They are all due to the action of bacteria. We consider here *tuberculosis*, *syphilis* and *glanders*.

TUBERCULOSIS.

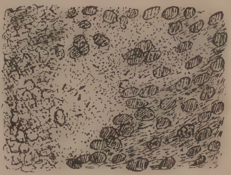
Historical Considerations. The literature of this subject is immense, but the older writings and investigations into the anatomy of the disease served more to confuse than to elucidate. The most important contributions are those of Laennec, Villemin and Koch. Laennec first made the diagnosis of pulmonary tuberculosis possible, by his teachings of physical diagnosis, but at the same time contributed to the misguiding anatomical classifications. Villemin showed that tuberculosis is an infectious disease, and produced it in lower animals by inoculation. Koch discovered and demonstrated the specific *bacillus tuberculosis*, and cleared up all the mystery.

Tuberculosis is an infectious disease which may manifest itself anywhere in the body, and therefore comes properly in the domain of General Pathology.

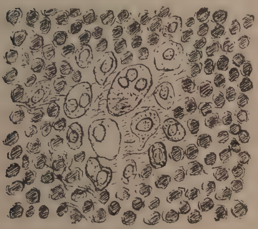
Lesions. The characteristic lesions are the *tubercles*, from which the disease takes its name. These are minute nodules, which may reach the size of a millet-seed, are gray-white, translucent and isolated. Later there is a tendency to the apposition of the tubercles, with formation of larger nodules, and finally they undergo degenerations,

rabbits, monkeys, Guinea pigs, ~~dogs~~ and pigs May get it spontaneously or may be given it artificially
The dog and rat are said to be immune

In the last case the gray and translucent appearance is lost and the tubercle becomes whitish-yellow and opaque, mainly from cheesy necrosis. This is called *yellow tubercle*, in distinction from *gray tubercle*, as the first is called. The yellow tubercle tends to undergo liquefaction, and to be discharged, if possible. When near a surface, *tubercular ulcer* results, which shows, besides the ordinary appearances of an ulcer, minute tubercular nodules at the bottom, some gray, others already cheesy. In the interior of organs the same tubercles occur, may undergo cheesy and liquefaction necrosis, and thus form cavities. Sometimes there is a tendency to the formation of connective tissue, which encloses and may hold the cheesy masses in its meshes for a long time. These *fibrous tubercles* are common in horned cattle, and are of especial interest, as they represent the method by which tuberculosis is often arrested—cured. Calcification of tubercles also occurs.


CHEESY TUBERCLE

Histology. Tuberculosis is a form of inflammation, an attempt to eliminate the bacillus. As this is difficult, a chronic inflammation, with tendency to regeneration, results. *A tubercle may then be healed.* This is not the usual result, because the blood-supply is poor, and in consequence degenerations are apt to occur: coagulation, cheesy and liquefaction necrosis.


TUBERCLE

We find in the tubercle (1) certain oval cells with large vesicular nuclei, (2) round cells with irregular, deeply-stained nuclei, and (3) giant cells. The first step in the formation of a tubercle is multiplication of the fixed connective-tissue cells, with production of the oval cells described. These are called *epithelioidal cells*, and present evidences of active karyokinesis. Around these as a centre are seen small, round cells with irregular, deeply-stained nuclei. These are wandering leucocytes, which infiltrate the tissue to eliminate the irritant. There is no difference from ordinary inflammation, except that there are no new blood-vessels, and, therefore, degenerations ensue. The first evidence of degeneration is a peculiar form of karyokinesis, in which the nuclei, but not the cell, divide, and thus are formed *giant cells*. This is seen in the centre, where we would expect degeneration, and is a regular occurrence in tubercles. Next follow other signs of degeneration, the first being coagulation necrosis in the giant cell. This is seen in the part of the cell opposite the nuclei, and renders the cell opaque. The nuclei in the affected part do not stain readily, but instead may show only a faintly-stained outline, with here and there a granule within. Subsequently the process extends and is followed by cheesy change. The stroma in the tubercle is that of the part involved—not new-formed.

Very often one or another element may predominate, as in tubercles of mucous membranes, which may be almost entirely made up of round cells. *Epithelioidal cells are always present*, but may be hidden, in the excess of round cells. Such a form is called *lymphoid tubercle*. Giant cells may also be hidden from view, or they may be absent entirely. They are found not alone in tubercles, but also in certain tumors, especially giant-cell sarcoma, in the uterine portion of the placenta, about foreign bodies, in syphilis, lepra, actinomycosis, and other conditions. They are therefore not diagnostic features.

Extension of Tuberculosis. Primarily a *local disease*, it may become general, involving, perhaps, all the organs of the body. The tubercle-bacillus is the specific cause and produces the lesions, which may become generalized in several ways.

1st. There may be extension by continuity and contiguity, the bacilli being carried out by wandering leucocytes.

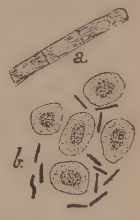
2d. Extension by the lymph-paths. This is a common way, and is well seen in the peritoneum when there are tubercular ulcers in the bowel. The extension is clearly traceable along the lymphatics of the peritoneal covering of the bowel, by the chains of tubercles. Extension by continuity is also frequent in the peritoneum.

3d. The disease may be spread by the movement of other fluids in the body; thus tubercular lesions in the mouth or pharynx may lead to infection of the air-passages by the downward trickling of mucus; or in lung-tuberculosis, if the sputum is not discharged, tuberculosis of the intestines may result.

4th. Extension may also occur by the blood. This gives rise to a rapid development of gray tubercles in different parts of the body, and is called acute miliary tuberculosis. It has been produced experimentally by injection of tubercular matter into the blood of animals.

The Tubercle-Bacillus. This is a rod-like bacterium 2 to 3 micromillimetres in length (a micromillimetre = $\frac{1}{25000}$ of an inch) and 0.2 micromillimetres in width. The bacilli often are bent on themselves, and sometimes are arranged end to end in chains. They may be structureless, or they may be clear, rounded spots which do not stain as well as the remaining portions These are generally regarded as spores. They cause a peculiar beaded appearance of the bacillus.

Staining. This will be more fully explained in the chapter on methods of staining. The most generally serviceable method is that of staining with carbol-fuchsin and decolorizing and counter-staining with Gabbet's solution.



Highly magnified and showing spores.

Position of the Bacillus in the Tissues. In the early stage, when the epithelioidal cells are being formed, the bacilli lie between the cells, and, perhaps, here and there in cells. When the giant cells begin to undergo coagulation necrosis, the bacilli are found in them, at the border between the healthy and diseased parts. Finally, they may be found in wandering cells, and experimentally have been found in the leucocytes in the blood itself.

Migration of the Bacilli. They have no flagellæ or other organs of locomotion; they have no motion. Therefore, changes of locality are brought about by outside agents. In the body-cavities this is by movement of fluids, as blood, food, etc.; in the tissues (1) by the movement of the lymph, and (2) by wandering leucocytes. This brings up the question of the function of leucocytes. It is claimed that leucocytes have the property of destroying cells, and especially bacteria. This is called **Phagocytosis,** and the leucocytes themselves the **Phagocytes.** The leucocytes do swallow bacteria, but it is more probable that they are destroyed by *juices* of the body, and that the leucocytes serve only to carry them from place to place, and thus sometimes to infect distant parts. Anything which favors activity in the motion of the juices and leucocytes would then tend to cause rapid spread of the disease, and it is just this unfortunate result that has followed the injection of Koch's lymph.

Cultivation of the Bacilli. Koch showed that the bacillus could not be cultivated on ordinary culture media, and first succeeded with inspissated *blood-serum.* A medium has since been found which is now commonly used. This is a bouillon-agar-glycerine mixture, containing from 5 to 8 per cent. of glycerine, and made slightly alkaline. The temperature must be kept very constant, and at about 37° C. Variations kill the organism. A certain humidity of the atmosphere of the incubator is necessary to prevent drying of the agar and destruction of the bacillus. Mixture with other organisms also interferes. Growth is very slow, and for seven days no change is seen on the surface of the agar. From this time to the fourteenth day, minute white spots appear, and in the first tube no further development may occur. In a second tube the characteristic growth may be obtained, and presents grayish-white, dry scales, which rise from the surface of the agar more markedly than any other other growth. Pure cultures are easily recognized by pressing out part of the growth on a cover-glass, when the bacilli are seen, by a low power of the microscope, to be close together, and arranged in S-shaped groups.

Pure Cultures. These are best obtained from tubercularized guinea-pigs. We must first produce experimental tuberculosis in the animal. The best method is to inject phthisical sputum into the peritoneal cavities of several guinea-pigs. Some will die in three or four days from septicæmia, due to the organisms of suppuration in the sputum. The successful animals show no symptoms until the seventh to the fourteenth day. With intraperitoneal injections we do not see the local lesions which are found in subcutaneous injections. These are, first, a subcutaneous indurated area, feeling much like a gland, then healing of the wound and subsequently breaking-out and establishment of a discharging sore. This is a characteristic appearance. Later the lymphatics are involved, the animal grows thin and dies after three or four months. To obtain pure cultures the pig is killed at the end of the eighth week, before the glands have become cheesy. A careful antiseptic *post mortem* examination is made, a lymph-gland removed, opened with a sterilized knife, and some of the juice inoculated in glycerine-agar tubes. Some will succeed, others fail to grow.

The bacillus does not lose virulence by successive cultivations. It has been found in many diseases not before regarded tubercular and their identity established. Thus in lupus, and others forms of chronic skin-disease, in the a "anatomical wart," in chronic bone-diseases, especially certain cranial bone-diseases, before regarded syphiletic, and in cold abscesses.

Introduction of the bacilli.

1. Food. The *meat* of tuberculous cattle may be the means of infection; and more often still, *milk* of affected cows. Thorough cooking of meat, at a temperature of 100° C. will kill all bacilli and spores, but dried and salted meats have been found to contain bacilli. Intestinal tuberculosis is produced in this way.

2. *Inhalation.* This is the commonest method of infection and gives rise to pulmonary tuberculosis. The bacilli or their spores which are resistive and retain their vitality a long time, lie in the dust of rooms and thus gain entrance to the lungs. Such dust has been collected in pans in hospital wards and other rooms, guinea-pigs inoculated with it, and in this way the disease produced. By experimenting with numbers of guinea-pigs, Cornet was able to show that the air of one room was richer in bacilli than another, according to the number of pigs infected in the experiments.

3. *Direct Inoculation.* This may be accidental in experimenters. In one instance a number of cases were traced to one person. A Jewish priest with tubercular lesions in his mouth infected a number of infants by applying his mouth, as custom directs, to the wound made in circumcision. Local tubercular lesions on the penis resulted. Skin-tuberculosis may result from direct inoculation by the discharges from sinuses of deep-seated lesions, especially those of bone in children.

Inherited Tuberculosis. The important question is, whether the disease is inherited or only the tendency to the disease. It is very probable *that direct inheritance does occur*, though it has never been clearly proved. In such cases there is transmission from the mother through the placenta or from the father in the semen. Transmission from a cow through the placenta to her calf has been demonstrated, but such cases are undoubtedly rare. The placenta resists the passage of the bacilli ordinarily, but probably in some cases this resistance is lessened and the bacilli pass through. The transmission of the bacillus from the father is still more rare, but may occur. Tubercle-bacilli have been found in the semen of animals, and even in the case of guinea-pigs, when there was no disease of the testicle. The last occurrence must be very rare and is a doubtful question, though there is some probability. What is it that is ordinarily inherited? The disease does certainly run in families, and very likely it is a *tendency* which is inherited. The juices of the body of persons with tubercular tendency are such that they predispose to tuberculosis; whereas in others the soil is unfavorable for the disease. Again, the children of tuberculous parents are especially exposed, as in nursing, breathing vitiated air, etc. Tendency to tuberculosis is marked in some species of animals and immunity in others. Thus the cat, dog, rabbit, small field-moose, and especially the guinea-pig are susceptible; but the white rat, the ordinary large rat, and especially the goat, are immune. It occurs in larger ruminants in a peculiar form, characterized by tubercular nodules in the serous membranes. This is called *pearl disease.*

Seats of Tubrculosis. In the child the lymph-glands, bones and serous membranes are particularly affected; in adults, the lungs.

Latent Tuberculosis. The bacillus may lie latent for a long time. This has been shown experimentally by inoculating eggs with bacilli. Healthy chickens were hatched, but later developed tuberculosis. The lymph-glands are the especial seat of latent tuberculosis. *Scrofula* is doubtless true tuberculosis, and though the bacilli or spores are not demonstrable by staining, inoculation experiments prove their presence.

SYPHILIS.

No micro-organismal agency has been proved, perhaps because the disease has not been produced in animals. A few observers claimed to have inoculated monkeys, but this is very doubtful. A bacillus was found by Lustgarten and claimed as the specific organism, but inoculations with pure cultures have failed to produce the disease.

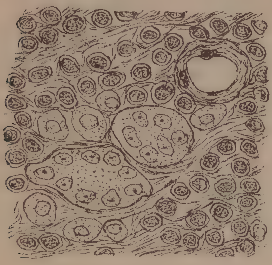
It is a bacillus closely resembling that of tuberculosis in appearance, and in that it holds aniline stains tenaciously, though unlike the tubercle bacillus, is easily decolorized by acids. This organism cannot be regarded as the cause of the disease. The poison of syphilis must come from syphilitic lesions of a syphilitic person, from the chancre or primary lesion, from the secondary manifestions, or from the blood.

1. The primary lesion, the Chancre. Two varieties occur, the soft and the hard; and two schools of Pathologists have arisen from this fact. The first, or *Unicists*, hold that all forms are identical, that there is but one form of venereal sore, the true chancre. Those of the other school, the *Dualists*, maintain that there are two forms of venereal sores, the true "hard chancre" and a "soft chancre" which is not syphilitic. Practically these schools are in closer accord than would seem, for the dualists admit that the soft chancre occasionally infects, explaining this on the assumption that there is a form of "mixed chancre," and the unicists recognize that the soft chancre usually does not infect, which they explain by assuming that certain destructive processes kill the poison in the chancre. In this country most authorities are dualists.

Histology. There is nothing peculiar in the histology of the chancre. It is merely a local cellular infiltration in the connective-tissue layer of the skin, *containing round cells, epithelioidal cells, and sometimes giant-cells.* The induration is probably due to a hardness of the intercellular substance, which cannot be demonstrated under the microscope; and to a certain extent to a sclerosis of the blood-vessels, a hyperplasia of the intima. This last is somewhat characteristic of the primary lesion of syphilis, and by occluding the vessels it leads to degeneration. After a few weeks a slow ulceration begins in the chancre. The common *seat* of chancre is the corona of the glans penis, between the skin and mucous membrane.

2. Secondary Manifestations. The first of these is the involvement of lymph-glands adjacent to the primary sore. There is nothing specific in this, other than what is seen in any infection of lymph-glands. Clinically, it is called *Indolent Bubo.* Next follow inflammatory lesions of the skin and mucous membrane, such as papules, vesicles, etc., just as in other diseases, or a peculiar form—the *Condyloma Latum* or *Mucous Patch.* This occurs in the skin and the mucous surfaces near skin borders, is circumscribed to the papillary layer and the deeper parts of the epidermis, and consists of a round-cell infiltration. A peculiar appearance is produced by an exudation of fluid which pushes the cuboidal cells of the skin apart. This is somewhat characteristic of the syphilitic lesion, but not always diagnostic. This exudation loosens the cells and finally causes them to be discharged, but there is *no true ulceration in the mucous patch.*

3. Tertiary Manifestations. These are found in deep-seated structures, especially bone and the viscera. *Gumma* is the characteristic lesion. It is also called *gummy tumor* and *syphiloma.* The gumma varies in size from a split pea to a small apple, is moderately hard, dull-white or grayish-red in color, and presents on section either a gelatinous, *gummy* appearance, or a mucous exudation. Translucent at first, it becomes whitish-yellow and opaque from fatty degeneration in the later stages. Very often there may be seen radiating fibrous trabeculæ, which constitute one of the most character-



istic appearances. In tuberculosis the center of coagulation necrosis, surrounded by epithelioidal cells is characteristic; in gumma the same center is found, and in addition the trabeculæ of fibrous tissue, holding the other parts in their meshes. Microscopically, there are seen round cells, epithelioidal cells and giant cells, and the connective tissue is found to be of different ages—in one part fully formed, in another merely round-celled. Some new blood vessels are formed, but few. The typical syphilitic blood-vessel is that with hyperplastic intima—*syphilitic endarteritis*. The substance within the fibrous meshes may become mucoid and jelly-like, or fatty and bacony in appearance.

Seats. Gummata occur (in order of frequency): (1) in bones, especially the skull, tibia and sternum; and (2) in the viscera, especially the liver, testicle, spleen, brain and its membranes, more rarely the kidneys and the lungs.

Hereditary Syphilis. This disease may be transmitted from the parent to the child in several ways, and various conditions are concerned.

1. A syphilitic father may beget a healthy or a syphilitic child, and infection in the latter may be *direct*, that is without primary infection of the mother.

2. Generally, however, the father first infects the mother.

3. The majority of cases of congenital syphilis are due to the disease in the mother. Very frequently no evidence of the disease is discovered in the mother, but the fact that she is not infected by the child in nursing and the like, proves her to be syphilitic. There is thus almost a *latent form* of the disease.

4. A fœtus rendered syphilitic *directly* from a syphilitic father may infect the mother without primary lesion, the secondary symptoms first proclaiming the disease.

5. Post-Conceptional Syphilis. The mother may acquire the disease during pregnancy. Exceptionally, she may then infect the child; usually she does not.

6. The more recent the syphilis in the mother, the more apt is the child to be infected and the more severe the manifestations.

The important points are that the infective agent may pass through the placenta either way, that is from mother to fœtus, or the reverse, and that the placenta offers some obstacle to this passage, so that it is not invariable.

Syphilis is a frequent cause of miscarriage, whether the mother or the fœtus is affected. This is usually due to inflammatory processes in the placenta or decidua. The child with congenital syphilis may not show signs of the disease at birth, and in such case usually manifests the taint three or four months later. The lesions resemble those of the adult, but there is a decided tendency to indurations, especially in lungs, pancreas and spleen. A marked leucocytosis is sometimes observed, and this probably has much to do with the indurations. "White Pneumonia" is a form of indurative, syphilitic pneumonia of the new-born. Gummata of the bones, liver, lungs and spleen may sometimes be seen soon after birth.

GLANDERS.

This is an infectious disease common in horses and asses, but communicable to other animals and to man. The cause is a bacillus resembling that of tuberculosis, but shorter and plumper. It occurs in considerable numbers in the lesions, but has never been found in the blood. It is difficult to stain, the best methods being Löffler's solution of methyl-blue for the stain, and dilute acetic acid to differentiate; or Weigert's method of staining with solution of gentian voilet in aniline oil water, and differentiation with iodine. We very frequently fail by any method. The bacilli occur in groups, in which the individuals are arranged end to end at acute angles, but often so dense that the separate bacilli cannot be distinguished. Cultivated at about 37° C., it grows readily on any medium, but characteristically only on potatoes, in which we see a honey-like mass, clear and amber-colored, growing larger and larger, and eventually also becoming darker and opaque. We can be absolutely sure of the bacillus only after inoculating animals. The horse or ass may be used, also the field-mouse, guinea-pig, and, to a degree, the rabbit. The ordinary rat or mouse will not serve.

In the horse and man also there are two forms:

(1). *Glanders* and (2) *Farcy* or *Farcy Buds*. The latter is more common in man than the former, and means cases in which the skin and lymph-glands are involved, whereas in the former the disease affects the mucous membranes of the passages, especially the nasal chambers, also the trachea, bronchi and lungs. Usually, however, there is a mixture of the two forms with greater involvement of one or the other group of localities.

Glanders. There are found in the mucous membranes nodules varying in size from a millet-seed to a cherry. Microscopically, these present a round-cell infiltration, with epithelioidal cells, but less than in tubercular nodules. The larger proportion of round-cells gives the nodules their marked tendency to break down, suppurate and form ulcers, which constitute a characteristic feature of the disease, giving a peculiar worm-eaten appearance to the mucous membrane from the running together of neighboring ulcers. The disease extends along the air-passages, rarely involving the trachea and bronchi as extensively as the nasal cavities, and finally, reaching the lungs, sets up scattered patches of catarrhal pneumonia, with much greater tendency to rapid breaking down than in tuberculosis. The lymph glands of the neck are always somewhat involved.

Farcy. In man the skin is the common seat, and hence farcy is more common than glanders. We find the same nodules with tendency to break down and form thick, cheesy pus. The lymph glands are decidedly involved. There are two varieties : an *acute*, terminating speedily in death ; and a *chronic*, in which one nodule after another appears in the skin and muscles, and finally perhaps in the mucus membranes, giving rise to glanders proper. This chronic form may be treated, the nodules being removed as rapidly as formed.

CHAPTER VI.

SPECIAL PATHOLOGY.

Under this head we study pathological processes as occurring in special tissues or organs.

THE BLOOD.

This fluid tissue has one marked peculiarity—viz., that its cells are supplied, not as in other tissues, by proliferation of the existing cells, but from some other organ, where they are formed. The pathological states of the blood are then really not diseases of the blood, but rather of other organs, and we study merely *conditions* of the blood. The *blood-making* structures are mainly the bone-marrow, the

5.

lymph-glands and the spleen; but there are also *blood-destroying* organs, of which the liver and spleen are important ones.

Changes in Quantity of Blood. The quantity may be increased, when we speak of *Plethora*, or it may be diminished, when we speak of *Oligæmia*—a better name than *Anæmia*, the one commonly used. These conditions without disease of the blood-making organs, must be very transient, and are very rare. Hemorrhage and transfusion bring them on, but normality is soon regained.

Changes in the Composition of Special Elements. We find this much more frequently in disease than changes of the quantity of the blood.

A. *Changes in the red corpuscles.* These may be increased in number—*Polycythæmia*, a condition generally due to withdrawal of watery elements, as by the serous discharge in cholera. At the same time there may be increase of size of red corpuscles—*Macrocytosis.* These enlarged red corpuscles or *macrocytes* may be ten micromillimeters in diameter (the normal being seven), but they do not indicate any increased nutrition or hyperplastic process, and are met with in some cases of anæmia.

Diminution of the number and diminution of the size of red corpuscles are more frequent than the opposite conditions. The general term *Anæmia* is applied to these conditions, but diminution of the number of red corpuscles is better called *Oligocythæmia.* This may be due to hemorrhage, or may be symptomatic, as when due to malnutrition from cancer of stomach, starvation and the like; to wasting discharges; poisons, as lead; or to micro-organisms, notably those of syphilis and malaria. Again there are certain obscure forms, not symptomatic as far as we know, and which are called *essential anæmias.* These are leukæmia, chlorosis, and progressive pernicious anæmia. The *immediate cause* of the oligocythæmia, *i. e.*, whether from increased destruction or decreased production of red corpuscles, is hard to find. When the red corpuscles are diminished in size, they are called *microcytes.* These may be only three or four micromillimeters, and may be associated with macrocytes. They are numerous after hemorrhage, and extensive burns and in oligocythæmia.

Alterations in the shape of the red corpuscles also occur. This is called *Poikilocytosis* and the corpuscles *Poikilocytes.* They are common in oligocythæmia, especially in progressive pernicious anæmia.

Nucleated Corpuscles. It has been proved that the red corpuscles, in their formation, are first nucleated. Such are seen normally in the blood of the fœtus, and in the adult, when, as a result of disease, they are projected into the blood from the blood-making organs in this stage.

B. Changes in the Hæmoglobin. The hæmoglobin may be reduced out of proportion to the dimination of the corpuscles. For instance, the number of red corpuscles may be nearly the normal—5,000,000 per cu. mm., and the hæmoglobin as low as 50 per cent. of the normal. This diminution of hæmoglobin (*Oligochromæmia*) is rather characteristic of chlorosis. The hæmoglobin is sometimes dissolved in the plasma—*Hæmoglabinæmia.* This occurs in some infectious diseases, and after injecting certain substances, into the blood, and may give rise to *hæmoglobinuria* or to excessive formation of bile pigments, which, by resorption in the intestines, cause jaundice.

C. Changes in the Leucocytes. These are frequently increased in number—a condition called *Leucocytosis.* This is present, in health, during digestion and in pregnancy. Pathologically, it occurs after hemorrhages, because the leucocytes adhere to the vessel walls and do not flow out, in inflammations and in many infectious diseases. In these cases the leucocytosis is never very marked and disappears with disappearance of the cause. In the disease called *Leucæmia* or *Leucocythæmia*, however, the condition is permanent and often extreme. Normally, the proportion of leucocytes to red corpuscles is as 1 : 700. (Different authors state the proportion differently.) In leucæmia we may find 1:1 or even more. The appearance of the blood may be milky.

The important feature, however, is not the number of leucocytes, since a *transient leucocytosis* may present a greater number than some cases of *true leucæmia*, but the character of the leucocytes which is materially changed. In normal blood the leucocytes are not readily stained with eosin, but in leucæmia there are numbers of leucocytes containing coarse granules, which stain intensely with eosin, and are, therefore, called *eosinophiles.* A mixture of saturated alcoholic solution of methyl blue and saturated watery solution of eosin serves as the staining fluid. The matter is much more complicated, but this is the main fact. (For details see chapter on staining, etc.)

D. Changes in the Plasma. Excess of water or plasma causes *hydræmia ;* decreased quantity, *anhydræmia.* The former results from failure of

The [illegible]

Toxines { The theory of Antitoxines in diseases as
Tetanus and Pl. Pneumonia.
Closing in the crisis of disease.

kidney excretion, such as accompanies cardiac disease and dropsy. *Anhydræmia* is well illustrated in the algid stage of cholera, when the excessive watery discharges have depleted the blood.

When the fibrin factors are excessive, we speak of *hyperinosis;* when decreased, of *hypinosis.*

Particles in the Plasma. These may be from various sources. (1) We may find portions of tumors, as cancer or sarcoma. (2) Other emboli, especially fibrin. (3) Portions of tissues, as, not infrequently, fragments of heart valves. (4) Pigment—insoluble blood pigments from destruction of red corpuscles in anæmic diseases, especially malaria. (5) Crystals, such as the Leyden-Charcot crystals, found in leucæmic blood after death—peculiar, long, octahedral crystals of doubtful composition, though probably a phosphate of an unknown organic base. (6) Fat droplets, which occur in excess normally during digestion and pregnancy; and pathologically in glycosuria, sometimes to such extent that the blood looks like an emulsion; also in fractures, when the fat of the marrow may gain entrance to the circulation, and, perhaps, by embolism of the pulmonary arteries cause death. (7) Micro-organisms, two, at least, of those found in the blood being certainly the cause of the disease. These are the *bacillus* of anthrax and the *spirochæta* of relapsing fever. The former occurs abundantly in the blood, more so than in the tissues, and may obstruct the capillaries of viscera. The *spirochæta* is readily found during the fever. Micrococci must of course occur in the blood in pyæmia, but they have never been clearly demonstrated, and we must look with distrust on all reports of micrococci in the blood, because they so readily gain access to and contaminate our cultures. In man, micrococci in the blood, have not been clearly connected with any disease. *Filaria sanguinis hominis.* The embryo of this worm, in thickness equal to the diameter of a red corpuscle, in length to 10 or 15 red corpuscles, is found in the blood in large numbers. The adult male and female reside in the lymphatic vessels. The organism often gives rise to chyluria, and is especially common in Tropical America and Asia. The malarial organism, falsely called a plasmodium, seems now to be definitely established as having some connection with the causation of the disease.

E. Chemical changes in the blood. Urates may be present in notable quantity in gout, especially the urate of sodium. Urea, of which there is but a trace normally, is in excess in *uræmia.* Acetone oc-

[illegible] Secondary [illegible]

Primary Idiopathic or Essential

curs in the urine, particularly in advanced stages of diabetes, and usually in such cases there is sudden death in coma. The condition is called *acetonæmia*. The amount of sugar may be doubled in diabetes.

Anæmia following Hemorrhage. As a primary result of hemorrhage there is decrease in the amount of blood, with a relative leucocytosis, due to the fact that the leucocytes cling to the vessel walls and do not escape. Later, from addition of watery elements from all the tissue, a hydræmic condition is produced with presence of nucleated red corpusles and microcytes. If not sufficiently severe to cause death, recovery of the normal condition occurs in about five weeks. When death occurs, it is (1) from anæmia of the brain, or (2) from fatty degeneration of the heart, which may occur very rapidly after copious hemorrhage.

The Essential Anæmias are those of which there is disease of the blood making organs. They are not secondary to other diseases. There are certain characteristics common to the different forms, such as, oligocythæmia, poikilocytosis, microcytosis, nucleated or developmental red corpuscles, and leucocytosis, also tendency to fatty degeneration and hemorrhages.

Leucæmia presents increased number of leucocytes as the marked feature, with distinct evidence of disease of the spleen, lymph glands or bone-marrow—constituting the splenic, lymphatic and myelogenic varieties.

Chlorosis is marked by great diminution of hæmoglobin and relatively little in the number of corpuscles. There is *hyperplasia* of the sexual organs, the heart and large blood-vessels, especially the aorta. The disease occurs almost always in young women.

Progressive Pernicious Anæmia presents no characteristic pathological conditions, though the clinical picture, with progressive course toward death, is well marked. The etiology is not clear. While some cases are apparantly "essential," others are unquestionably due to disturbances of the digestive organs, especially atrophy and fatty degeneration of the mucous membrane of the stomach and intestines. In some cases parasites in the intestines are the causative agency. The oligocythæmia may be intense,—perhaps as few as a few hundred thousand red corpuscles and poikilocytosis is also extreme. Hæmoglobin is relatively excessive, that is, reduction of corpuscles far exceeds that of the coloring matter, so that the latter is relatively increased, though really diminished.

Ditto

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LYMPH-GLANDS.

Anatomy. The lymph-gland presents a capsule, from inner surface of which trabeculæ extend toward the centre, enclosing masses of lymphadenoid tissue. The latter consists of a net-work formed of stellate-cells, whose meshes are lined with endothelial cells and filled with leucocytes. The functions of these glands are: (*a*) to form blood corpuscles, and (*b*) to filter the lymph, for this flows between the cells of the lymphadenoid tissue. In this way injurious substances are often prevented from being spread in the circulation, but, at the same time, diseases of the lymph-glands may result.

MORBID PROCESSES IN LYMPH-GLANDS.

1. Pigmentation is quite common, the pigment being often derived from the blood. Thus, in cases of absorbtion of hemorrhagic extravasations, the neighboring lymph-glands are found pigmented. Particles of coal-dust and other foreign pigments may also be found, especially in the bronchial lymph-glands. These particles pierce the lung tissues, but are arrested in the glands, where they may lodge harmlessly or cause hyperplasia of the connective-tissue, and therefore induration of the glands.

2. Inflammation of Lymph-Glands, Lymphadenitis. When micro-organisms are carried from an inflamed area to the lymph-glands, they are apt to set up inflammation in the glands; and such is generally the way in which lymphadenitis occurs. It is characterized by the same processes as are seen in inflammatory areas elsewhere: proliferation of all the cellular constituents, outwandering of leucocytes, and the appearance of an almost new form of cell—the epithelioidal. These last are really only proliferations of the endothelial cells, which are themselves epithelioidal, lining the meshes of the lymphadenoid reticulum. Microscopically, the gland is swollen, reddened, especially about the capsule, and on section, copious liquid exudes. The inflammation is specific and similar to that in the original seat of disease.

The *terminations* are: resolution; when that fails, generally suppuration or "bubo"; rarely gangrene; or, when repeated, induration.

3. Purulent Lymphadenitis. Bubo. The most common seat is in the inguinal glands, following soft chancre. Micro-organisms are carried to the glands from the sore and cause an abcess.

4. Other Specific Inflammations. In a great variety of

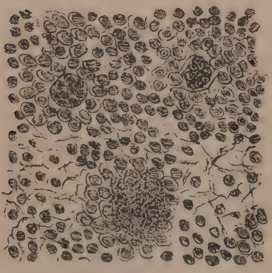
4. [illegible] C, normal in [illegible] is 4 [illegible]

5. [illegible]

specific diseases the same process may occur as in soft chancre. Thus in glanders, in leprosy, or in the local form of anthrax, called malignant pustule, we may find acute lymphadenitis and bubo. In typhoid fever the same process of cell proliferation as seen in Peyer's patches occurs in the mesenteric glands, and in like manner, when this proliferation becomes excessive, circulation in the glands is stopped, anæmia, followed by necrosis and ulceration results, and in this way not rarely peritonitis. In syphilis, too, there is proliferation of cells in the glands, partly due to irritants carried from the chancre to the adjacent glands; but also, to an extent, to a general tendency to lymphatic hyperplasia, characteristic of the early stages of the disease. The trabeculæ are especially involved, and hence syphilitic glands are hard. Gummata are rare. In the Plague of the East there is marked tendency to inguinal bubo.

5. Chronic Lymphadenitis. In the above diseases, except syphilis, we see acute inflammation, but there are certain cases in which slow, chronic processes occur. Thus, from long-standing irritation in the mouth, overgrowth of the cervical glands occurs, and to such the name *Lymphadenoma* has been wrongly applied. They are not tumors, and the cases in which no cause is apparent are very likely due to slight irritation of the mucous membrane of the mouth, which is overlooked.

In *tuberculosis* there is a peculiar tendency to more or less permanent enlargement of the lymph-glands. This has generally been called *Scrofula*, but the tubercular nature is proved by injecting portions of the glands into animals, when tuberculosis results. It may be impossible to demonstrate the bacilli in the glands, either because of their fewness, or because they are in an unstainable condition. Tubercular lymph-glands may show miliary tubercles, but beyond this, nothing characteristic. There is hyperplasia, especially of the endothelial cells, which, to an extent, is characteristic, and is comparable to the proliferation of the ephithelial cells in catarrhal pneumonia. These proliferated epithelioidal cells accumulate and tend to undergo cheesy change, which is also to a slight extent characteristic.



Tubereles in Lympy-gland.

6. **Tumors.** Lymph-gland tumors, generally called *Malignant*

Lymphadenomata, are classified as (*a*) leucæmic, or (*b*) non-leucæmic, according as they are associated with leucæmia or not. The non-leucæmic occur in Hodgkin's disease. There is no structural difference, except that in the leucæmic the lymph-spaces can be injected, but not in the non-leucæmic. Very probably both forms are infectious diseases, therefore merely hyperplasias from irritation, and not true tumors. Sometimes the trabeculæ are particularly involved, when we get "hard lymphoma"; sometimes the pulp, when it is "soft lymphoma."

Of other tumors carcinoma and sarcoma may occur, especially secondary cancer.

THE SPLEEN.

The weight of the spleen is about 200 g., or, compared with the body weight, as 1 : 400. It is 14 cm. long, 4 cm. wide, and 2 cm. thick.

This organ acts as a filter to the blood. The blood-vessels, after breaking up into small branches, lose their walls and allow the blood to flow between the cells of the pulp. Another peculiar feature are the *lymph-follicles* or *Malpighian bodies*—closely massed groups of lymphoid cells, lying on or surrounding the arteries, just before their division into the terminal branches.

The functions of the spleen are, to filter the blood, to manufacture red and white corpuscles, and to destroy the former. Pathologically, evidences of disturbed blood destruction are clearer than those of disturbance in formation of corpuscles.

MORBID PROCESSES.

Degeneration

1. **Amyloid Infiltration** may be diffuse or circumscribed. In the latter, the lymph-follicles or Malpighian bodies are especially involved, and the appearance called "Sago-Spleen" results. In other cases a more uniform distribution of the process is seen, and the organ may reach great size. Amyloid spleen usually accompanies the same process in the kidneys and liver, and is due to certain cachexias, notably those of syphilis and tuberculosis, attended with prolonged suppuration.

2. **Pigmentation** is due to destruction of red corpuscles, and is marked in certain infectious diseases, especially malaria. More or less pigmentation is normal to the spleen.

3. **Atrophy** of the spleen occurs in old people, and is a result of great malnutrition or starvation.

4. Embolism and Thrombosis may occur in the splenic vessels, though the latter is uncommon. Embolism is common, and gives rise to anæmic or hemorrhagic infarctions. The latter presents at first a dark-colored, wedge-shaped area, the base of the wedge being toward the periphery, slightly elevated, and harder than the surrounding tissues. Later, fatty degeneration ensues, the extravasated blood is absorbed, leaving behind it marked traces of pigment, and finally a scar is formed in place of the tissues removed. Anæmic infarction differs only in the absence of blood, the wedge-shaped area being pale, and the resulting scar not pigmented.

5. Passive Congestion is very common in disturbances of the portal circulation, and in valvular heart disease. The continuous hyperæmia causes connective-tissue hyperplasia, as a result of which the capsule and trabeculæ of the organ are greatly thickened. When this new-formed connective-tissue contracts, the spleen becomes small, hard and dark-colored, and is called " Cyanotic Spleen."

6. Active Hyheræmia and Inflammation are hard to distinguish, the one from the other, because there are no capillaries in the spleen, and the processes of overfilling, exudation and the rest, cannot be observed. We, therefore, study the two conditions as one.

The condition of active hyheræmia, or *acute splenitis*, occurs principally in certain infectious diseases, of which malaria and typhoid fever are most important, and is called " Acute Splenic Tumor." The spleen is enlarged, soft even to fluctuation, and may burst its capsule during life or when being removed *post mortem.* The pulp is swollen and stands out from the trabeculæ on the cut surface, giving a granular appearance. It may be scraped from the surface, along with blood, which is present in great quantity. In other cases the organ is more firm. *Microscopically*, evidence of inflammation is found in the active proliferation of endothelial cells, cells showing evidences of rapid multiplication, along with free nuclei, leucocytes, detritus, and cells containing red corpuscles. The last is a normal occurrence, but is seen in excess in this condition.

In some diseases there is tendency to involvement of the lymphatic follicles alone. Such occurs in scarlet fever, and occasionally in typhoid fever.

The tendency of splenic tumor is to recover, but sometimes areas undergo fatty degeneration, necrosis, and finally absorption; or, if specific micro-organisms have gained entrance, abcesses may result.

The last are usually embolic. These large spleens may contain important elements for diagnosis, especially in malaria and typhoid fever. A long needle is thrust into the organ, and the blood thus obtained examined for plasmodia or typhoid bacilli. also in anthrax

7. **Suppurative Splenitis or Abscess of the Spleen** may result from embolism, as described above, and in such case multiple foci of suppuration may be found. Again, abscess may result from perforation of a gastric ulcer into the spleen, or from extension of suppurative inflammation in neighboring structures. The termination is in rupture into the peritoneal cavity, into adjacent organs or externally.

8. **Indurative Splenitis** is a chronic form most commonly due to repeated attacks of acute splenitis or hyperæmia, leading finally to a special hyperplasia of the connective tissue of the organ—the capsule and the trabeculæ. As a result, the spleen is first enlarged, but later contracted; the capsule is thick; and the trabeculæ, almost invisible in the healthy organ, become prominent. Malaria is the disease in which indurative splenitis is commonest, and the name "Ague-Cake" is frequently applied to the enlarged spleen. Besides the connective-tissue overgrowth, there is also hypertrophy of the other structures, and great pigmentation from deposit of hæmosiderin, resulting from destruction of red corpuscles. The organ is apt to be slate-colored. Sometimes there is uniform hypertrophy, and, therefore, no pathognomonic characteristic can be described for malarial spleen.

9. **"Leucæmic Tumor"** is the name applied to the enlarged spleen of leucæmia, but is a misnomer. It is not a true tumor, but, like the enlarged lymph-glands in the same disease, merely a hyperplasia for functional purposes. There is a tendency for this hyperplasia to affect mainly the Malpighian bodies. In such case the hyperplastic follicles are so distributed—along the course of the blood-vessels—that a mottled, "marbled," or "granitic" appearance is produced, the light-colored areas being the areas of hyperplasia. In other cases there is uniform involvement of the spleen.

These conditions are not characteristic of leucæmia, but occur also in pseudo-leucæmia, or Hodgkin's disease. Do not know whether primary or secondary.

Chronic splenic enlargements are not as common in the child as in the adult; but malarial enlargements do occur at quite early ages, and even *in utero*.

10. **Other Infectious Diseases** may present splenic involve-

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ment. (1) Tuberculosis is almost always secondary, presenting either miliary nodules in large numbers, as part of a general miliary tuberculosis, or a few larger nodules, tending to cheesy change. (2) Syphilis may present gummata, which are characteristic, or a general indurative splenitis, in no way characteristic.

11. Tumors. Sarcoma is rarely primary, the most cammon occurrence being secondary melanotic. Cancer is always secondary. Angioma and cysts of parasites, especially the echinococcus, also occur.

THE THYMUS GLAND.

This gland resembles the lymph-glands in structure, having a capsule, from the inner surface of which trabeculæ extend inward, making lobules composed of lymph-adenoid tissue. The latter is denser at the periphery than in the centre, and thus a cortical and medullary portion are formed. There are also certain bodies composed of concentrically arranged epithelial cells, situated in the medullary portion and indicating the epithelial origin of the gland. At birth the gland weighs about 13 g., it increases to 26 g. at two years, and then decreases until at twenty there is rarely much remaining. Little can be said of its function, though it is supposed to aid in the formation of blood-corpuscles. Abscence of the thymus has occasionally occurred in otherwise normal individuals, but especially in deformed persons.

MORBID PROCESSES.

1. Hemorrhage may occur in cases of asphyxia or hemorrhagic diathesis.

2. Fatty Degeneration and **Infiltration** accompany the atrophy of the organ, the former affecting the lymphoid cells and causing their absorbtion, the latter, the connective tissue, and so forming the fatty tissue which is the remnant of the gland.

3. Calcareous Infiltration is found in the concentric bodies before described.

4. Infectious Processes. Suppurative inflammation—abscess—may be produced by extension from neighboring structures, but more often by emboli in pyæmia, when there are usually several foci. Tuberculosis is always secondary, and presents either miliary nodules or larger and cheesy masses. Gummata are occasionally found as evidence of syphilis.

5. Tumors. Lymphadenoma is the commonest new growth, and may give rise to serious pressure symptoms, even suffocation. This swelling is not a true tumor, but like the enlargement of the other glands in lucæmia, the disease in which it mainly occurs, of the nature of a functional hyperplasia. Sarcoma may also occur.

THE BONE MARROW.

The histological structure of this resembles that of the thymus gland and other lymphatic tissues. It is composed of a lymphadenoid reticulum filled with lymphoid cells, having a somewhat large and clear nucleus, nucleated and ordinary red corpuscles, granular and pigmented cells and giant cells. The tissue is also rich in blood-vessels. Such is the "red" or "lymphoid" marrow, found in all of the bones at birth; but later, as adult age is approached, the marrow of the long bones becomes fatty and in consequence "yellow," though the lymphoid character is still retained in flat and irregular bones. The function of bone marrow is to manufacture blood-corpuscles.

MORBID CONDITIONS AFFECTING THE MARROW.

1. Acute Anæmia from hemorrhage causes more or less marked changes in the marrow. The fat is absorbed and the lymphoid character resumed, but these alterations are confined to the ends of the medullary cavity.

2. In Pernicious Anæmia a similar condition prevails, but affects the whole medulla. Microscopically, many nucleated red corpuscles are seen, as well as Charcot-Leyden crystals. The marrow is dark red—*splenization.*

3. Leucæmia may show little or great involvement,—the case in the latter instance being called "myelogenic." At first a mottled appearance may be produced from the special increase of lymphoid cells contrasting with the dark red areas around, and later the appearance of purulent foci may be simulated.

4. In Acute Infectious Diseases the marrow loses its fatty character, and again becomes embryonal or lymphoid. There is also fatty degeneration of the blood-vessels. The changes somewhat resemble those of the spleen in acute splenic tumor.

THE PERICARDIUM.

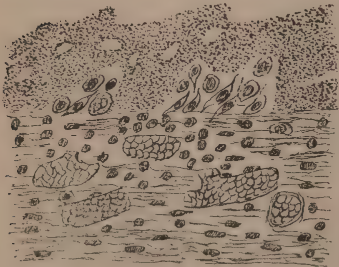
The pericardium is a serous membrane like the pleura, and consists of two folds,—one lining the heart, and called the *visceral layer* or *epicardium*, the other covering the structures which enclose the mediastinum, and called the *parietal layer.* The cavity formed by these folds is the pericardial sac. It contains a little clear, serous fluid,—not above 100 c. c. in conditions of health. The membrane is covered with endothelial cells, and consists of connective tissue, with considerable yellow, elastic fiber.

MORBID PROCESSES.

1. **Fatty Infiltration** may become marked in the visceral layer, and especially along the course of the blood-vessels. This occurs normally with advancing age, in cases of obesity, and in wasting conditions of the heart muscle. When extreme, the infiltration may extend into the myocardium, between the fibers.

2. **Hyperæmia** may give rise to urgent symptoms, and, therefore, is very important. In cases of asphyxia, the hyperæmia may be of such degree that small hemorrhages (ecchymoses) occur on the surface of the heart. Similar appearances are seen in phosphorus poisoning, and in certain infectious and hemorrhagic diseases. The more common result of hyperæmia is *serous effusion into the sac.* This is caused mainly by valvular heart disease, and as a part of the dropsy of Bright's disease. In these cases there is sometimes a dropsical condition of the pericardium itself, but more often this is of normal appearance.

3. **Pericarditis** is divided into several varities, according to the character of the exudate. As in all inflammations of serous membranes fibrin is conspicous. If very conspicuous, we speak of *fibrinous pericarditis*; if less so and associated with much fluid, of *sero-fibrinous pericarditis;* and lastly, when the number of leucocytes predominates, the case becomes one of *purulent pericarditis.*



The first step in the process of inflammation is hyperæmia, followed by proliferation of the endothelial cells and their desquamation. Next fibrin is formed on the surface and the processes of inflammation proceed in the underlying tissue. There is overfilling of the blood-vessels, exudation of leucocytes, proliferation of cells and formation of new vessels. Finally, the fibrin disappears, and in its place comes new formed connective tissue, always easily distinguishable from the old connective tissue of the pericardium by the absence of elastic fibers. If inflammation has occurred at the same time in the visceral and parietal pericardium, the new blood-vessels and finally the new connective tissue may extend across from the one to the other layer with formation of "adhesions." If the process was extensive the pericardial sac may be entirely obliterated in this way.

Macroscopically, the appearance of the membrane varies with the character of the exudation. Very frequently when there is much fibrinous deposit the to and fro motion of the pericardial layers causes an appearance likened to that seen when two pieces of bread are pressed together with butter between and then separated. Again, a "honey-comb" appearance may be seen, or if less fibrin is present a finer corrugation, likened to the roughness of a cat's tongue is produced. In sero-fibrinous inflammation there is considerable clear fluid containing flakes of fibrin.

Causes. 1. Rheumatism is the commonest cause. It is not known how this induces pericarditis. 2. Bright's disease, by action of products of cell metabolism. 3. Acute infectious diseases, like scarlet fever, measles, typhoid, etc., in which the specific microorganisms are probably responsible. 4. Extension of inflammation from the lung, pleura and other neighboring structures.

Results. Sometimes as a result of a localized inflammation, there may be formed small spots of thickened pericardium, called from their opaque, white appearance "milk-spots." These spots may sometimes be the result of slow sclerotic changes occurring in old age. A common consequence of pericarditis is adhesion between the parietal and visceral layer. This necessarily impedes the heart action and therefore gives rise to hypertrophy. Finally, as the difficulty increases with contraction of the new formed connective-tissue, atrophy of the heart results.

Very commonly the inflammatory process extends from the pericardium into the heart muscle, froming new tissue between the fibres; or if the pericarditis was specific—(purulent)—the same process extends into the heart-muscle and abscess results.

Suppurative Pericarditis presents the same appearance as the other forms but there is in addition pus in the exudate. The process is like that of suppuration elsewhere except that there is a predominance of fibrin formation. The organisms of suppuration occur as elsewhere, having reached the pericardium either by extension from adjacent suppurations, as of the pleura, lungs, etc., or by the circulation, as in cases of pyæmia in the puerperal state.

4. Infectious Diseases. Tuberculosis may appear as miliary tubercles, as a part of general miliary tuberculosis, or as cheesy nodules. The latter is caused by extension from the lungs. Cases of primary tuberculosis of the pericardium, with tubercles only in this structure, occasionally occur but are rare, most instances being secondary. Certain chronic cases of pericarditis not recognized until post-mortem are probably tubercular.

5. Tumors are rare and arise by extension from neighboring structures.

THE HEART.

The size of the heart is approximately that of the fist of the individual. The weight varies, as follows:

At birth,	21 grams,
At the end of 1st year,	37 grams,
Between 2 and 5 years,	50 to 70 grams
“ 6 “ 10 “	77 “ 115 “
“ 11 “ 15 “	130 “ 205 “
“ 21 “ 30 “	260 “ 294 “
“ 30 “ 50 “	294 “ 308 “
“ 50 “ 65 “	308 “ 332 “

The proportion of the heart weight to that of the body is as 1:175.

The thickness of the walls is of importance as indicating the condition of the muscle. The left ventricle is from 7 to 10 mm. thick, the right from 2 to 4½ mm. The left ventricle is 90 mm. in length.

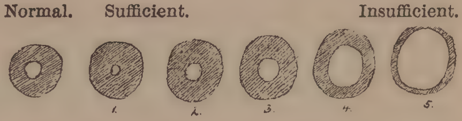
Histology. The heart muscle is composed of striated fibers, 70 micromillimeters in length, and 15 to 23 in width, presenting no distinct sarcolemma, and being branched and anastomosing. Externally, the heart is covered by the pericardium, and internally by another serous membrane, the endocardium, which is covered by endothelial cells, and in its lower layers composed of much yellow elastic tissue, especially where, as in the auricles, the heart is thin. Some smooth muscle fibers are also found, notably in the valves, which are reduplications of the endocardium containing elastic tissue and smooth muscle fiber. The auriculo-ventricular are supplied with blood-vessels, whereas the semilunar contain none at all.

The blood supply of the heart muscle is derived from the coronary arteries, which arise from the aorta immediately outside the valves, and are filled, not as was formerly thought during diastole, but during the systole of the heart.

Functionally, the heart is merely a pump, which propels the blood in given directions.

MORBID PROCESSES OF THE HEART MUSCLE.

1. Enlargement of the heart may be of several kinds, as—(1) hypertrophy with diminution of the cavity; (2) hypertrophy with cavity of normal size; (3) hypertrophy with enlarged cavity; (4) enlargement of the heart with walls of normal thickness, the cavity being enlarged; (5) enlargement with thinning of the walls. Clinically these enlargements may be classed as—(a) those with sufficiency, and (b), those with insufficiency. In the former the hypertrophy is *sufficient* to counteract the obstruction, which is the cause of the hypertrophy; in the latter, the enlargement is insufficient.



When we come to study the five forms of enlargement with reference to these two heads, it is found that the first four are "sufficient," the last three "insufficient," the third and fourth form being included, both among the sufficient and the insufficient. (1) Hypertrophy with diminished cavity is called *concentric hypertrophy*, and may occasionally cause "over-sufficiency," the hypertrophy exceeding the needs. (2) Hypertrophy with normal cavity is the ordinary, sufficient form. (3) Hypertrophy with enlarged cavity, sometimes called *eccentric hypertrophy*, is at first sufficient, but later becomes insufficient from degeneration of the muscle-fibers and consequent dilatation. (4) The form with walls of about normal thickness, but enlarged cavity, though truly a hypertrophy, since the walls must increase to maintain normal thickness with the enlarged cavity, is usually insufficient. Occasionally it is sufficient. Together with the third form, it is sometimes spoken of as "hypertrophy with dilatation." (5) The fifth form is purely insufficient.

These conditions, though described as if occurring in one cavity of the heart, may occur in all. They are commonest in the left heart, but eventually also affect the right.

Causes of Hypertrophy.

1. Direct mechanical interference with the cardiac function, as by pressure from neighboring organs, or by pericardial adhesions.

2. Disturbance of the valvular mechanism is the commones cause, and acts by interfering with the normal flow of blood.

3. Disturbance in the general circulation. Increased resistence in the arteries, as from atheroma or in Bright's disease.

4. Disturbance in pulmonic circulation, either as a result of congenital cardiac anomalies leading to obstruction, or from diseases of the lungs as emphysema and filbroid phthisis. In these cases the right side of the heart is involved.

5. "Idiopathic hypertrophy" is the name applied to cases in which no mechanical cause is evident. Very often some nervous action causes the excessive work which leads to hypertrophy. Thus, in Graves' disease the constant palpitations finally bring on hypertrophy.

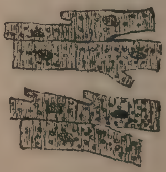
Histology. Both simple and numerical hypertrophy occur, but the latter is the more frequent.

2. Atrophy of the Heart is sometimes the result of marasmus, inanition and senile debility. It may also follow pericardial adhesions. There is a form of congenital deficiency of cardiac development (called *hypoplasia*), which occurs in people with tubercular tendency, and in chlorotics.

Brown Atrophy or Cyanotic Induration is a special form, caused by congestion of the muscle, and characterised by pigmentation of the fibers. The last may be so extensive that the muscle substance in the fibers is almost entirely replaced by pigment granules. Pigmentation begins at either end of the nucleus and extends along the fiber.

3. Infiltrations. *Fatty infiltration* is the commonest of these, and occurs especially in obesity. There is deposition of fat in the pericardium and in the muscle between the fibers. *Amyloid infiltration* also occurs and affects the connective tissue. *Calcification* is not rare in the valves, and may affect the fibrous ring at the auriculo-ventricular orifice and occasionally the muscle fibers themselves.

4. Fatty Degeneration is the most important of the degenerative changes. It begins as cloudy swelling, when the fibers are granular and clear up with acetic acid, but later distinct fatty change occurs, and the granules no longer dissolve in the acid. At first there is a peculiar arrangement of the granules in longitudinal lines, but afterwards they are uniformally distributed and obscure the striæ.



The process may be diffuse when the heart presents a yellowish appearance, but in the earlier stages, and perhaps in the majority of cases, it is irregularly distributed and seen as yellowish patches shining through the endocardium.

Causes. 1. Poisons, such as cause fatty degeneration in other situations, like phosphorus, arsenic or iodoform. Chloroform may cause rapid degeneration, and in this way sometimes kills. 2. Infectious febrile diseases always cause cloudy swelling, and the process may stop there. In other cases, as in typhoid fever, malaria and diphtheria, fatty degeneration may follow and occasionally causes sudden death. 3. Anæmia. 4. Local disturbance of the valvular mechanism is the most important cause.

The coronary arteries are not filled as was thought during diastole, but in systole. Their position, however, makes their supply difficult and easily disturbed and, in consequence, inadequate mitrition and fatty degeneration result. These disturbances are accentruated in enlarged hearts, and we find fatty degeneration most likely to appear at the stage of eccentric hypertrophy.

5. Hyaline Degeneration may occur in certain acute infections diseases, but is rare.

6. Circulatory Disturbances. Both *thrombosis* and embolism of the coronary artersis occur; though the latter is rare. They give rise to anæmic or hemorrhagic infarction, followed by degeneration. In the anæmic infarcts, the more common of the two, the affected area undergoes coagulation necrosis, fatty degeneration and softening. To this condition the name *myomalacia cordis* has been applied. In some cases there may be rapid and extensive softening, leading to rupture of the heart; in others a slower process with time for regeneration, cicatrization. The resulting scar gives no trouble at first, but may later undergo dilatation with production of cardiac aneurism. These scars are most frequently seen near the apex, on the anterior or posterior walls. Sometimes the softening area ruptures internally and thus causes embolism with its consequences.

7. Inflammation of the Heart Muscle. Myocarditis.

(*a*). The form described as *parenchymatous myocarditis* is merely cloudy swelling, not inflammation at all. It is common in acute infectious diseases. Dolt and Ohagne

(*b*). *Suppurative myocarditis*, or abscess of the heart results from extension of the inflammation from the pericardium, or the endocar-

[illegible]

dium in ulcerative endocarditis, or from septic embolism of the coronary arteries. The consequences are like those of myomalacia.

(*c*). *Interstitial or Sclerotic Myocarditis* is characterized by connective-tissue formation. It may be the outcome of the regeneration in areas of softening, the result being a scar, or it may be caused by extension of sclerotic processes in the endocardium and pericardium into the muscle. The walls become, in consequence, weak and yielding, and aneurism or rupture may follow.

8. Endocarditis is of three varieties :

A. Verrucose, or warty endocarditis.

B. Ulcerative, malignant, necrotic, diphtheritic, or mycotic endocarditis.

C. Indurative or sclerotic (including atheromatous) endocarditis.

A. Warty Endocarditis presents on the surface of the endocardium small projections, resembling in appearance *Condylomata*, sometimes rounded, but at other times a longitudinal crest like a cock's comb. Generally, the process is circumscribed to the line of closure of the valves. This line is about a twelfth of an inch from the free edge of the leaflet. These warty masses are composed of fibrin, derived (*a*) from the blood passing over the endocardium, or (*b*) from the exudation in the tissues of the valve. Beneath this may be seen the same processes of inflammation as in pericarditis: proliferation of connective tissue and endothelial cells, formation of new blood-vessels, and, finally, new fibrous tissue. Very probably the process is always due to micro-organismal activity, but in some cases no bacteria can be demonstrated by staining or by culture. In the majority of cases, however, they have been found, and since the process occurs especially with diseases of bacterian origin, most probably when the bacteria are not found, they have previously died. The tendency of warty endocarditis is to recovery, a further indication of probable early death of the micro-organisms. Of the diseases in which warty endocarditis occurs, pneumonia, pyæmic processes, scarlet fever and diphtheria are prominent. The bacteria most commonly found are those of suppuration. Warty endocarditis bears about the same relation to ulcerative that croupous inflammations do to diph-

Takes place in all ages.
Rheumatism a frequent cause

Infections " " " Especially in [illegible] theritic, the first named in each case being a superficial, relatively benign process.

B. Ulcerative Endocarditis varies in appearance, according to the severity of the process, from a mere opacity and roughening to the most destructive changes. The ulceration may be so extreme that slight stumps alone remain of the valves, the muscle may be deeply penetrated, or even perforation of the heart may occur. There is always more or less deposit of fibrin on the surface, sometimes even giving the appearance of a warty endocarditis, though the ulcers may be disclosed by tearing off the fibrin. In other cases there is special deposition about the edges of the ulcer, so that it appears much deeper than it is. In cases where fibrin deposit is excessive, a distinct mass may be produced, and the name *endocarditis polyposa* has been applied. When ulcers are more prominent we say *endocarditis ulcerosa*, while in still other cases minute abscesses may occur in the substance of the valve, and the name *endocarditis pustulosa* is given it.

Microscopically, there are seen the appearances of intense inflammation, terminating in destructive changes. Round cell infiltration is prominent, and the micro-organisms, demonstrated by Gram's method, may be densely packed in the tissues. Later, degenerative changes ensue, with production of areas of suppuration or necrotic softening, and discharge into the circulation.

Cause. Unquestionably micro-organismal. Any of the organisms of suppuration, but especially *Stophylococcus pyogenes aureus* and *Streptococcus pyogenes* may be found; also *Diplococcus pneumoniæ*, *Bacillus fœtidus*, and a micrococcus found only in connection with endocarditis, the *Micrococcus endocarditidis*. The last is rare. The disease may occur in pneumonia, the puerperal septicæmias and pyæmias, or any form of pyæmia. It may be induced in animals. Experimentally by *first causing some injury to the valves* and then injecting micro-organisms.

Seats. The process begins at the contact-margin of the valves, for here they are subjected to the greatest friction and are liable to injury. The micro-organisms sweeping over these valves in the circulation find the abrasions in the endothelium and thus infect. Perhaps in some cases the bacteria may be carried in the circulation of the heart itself, but this must be rare, as emboli of the coronary artery commonly lodge in the *muscle* near the apex. The aortic valves are most commonly involved, then the mitral. From these points

a great tendency to coagulation necrosis infection extends by transfer of the bacteria along the blood-stream.

The *results* of the process are: (1) the local destructive changes, (2) septicæmia, and (3) embolism, causing the same process in the secondary foci as occurred in the original seat—usually suppuration.

C. Sclerotic Endocarditis is characterized by the formation of connective-tissue, the product either of regenerative changes following the warty or ulcerative forms, or of a slow and primarily sclerotic process, accompanying chronic inflammatory changes in the general circulation. The appearance varies from a slight thickening of the contact-margin of the valve to the most extensive sclerotic changes. The latter may so distort, agglutinate or contract the valves that they may on the one hand seriously oppose the passage of the blood through the orifice or on the other allow its regurgitation. "Obstructive" and "Insufficient" valves are produced in this way.

All parts of the endocardium may be involved—that of the valves or that covering the *cordæ tendineæ* the papillary muscles or the body of the heart itself. Most common in advanced life.

Microscopically, connective-tissue hyperplasia is the most prominent feature—first round cells, then new blood-vessels, and finally fully-formed connective tissue. In many cases, however, the arteries of the affected area themselves may show hyperplastic changes, as a result the nourishment of the new tissue is impaired and fatty degeneration results. Such a condition is called *atheromatous endocarditis.* Usually these patches of fatty degeneration remain in the same condition, but in some cases they may go on to more complete disorganization, and discharge on the surface, leaving an "atheromatous ulcer." In other cases calcification may occur with formation of plates. Anenrism of the heart may also follow.

9. Tumors of the Heart are generally secondary, the most frequent being melanotic sarcoma. Cancer also occurs, but is always secondary. Of primary growths there are filbroma, lipoma and rhabdomyoma.

10. Infectious Diseases. We might properly include all of the forms of endocarditis. *Tuberculosis* affects mainly the right side, presenting miliary tubercles under the pericardium of the right ventricle.

THE ARTERIES.

The arterial wall is composed of three layers, the intima or inner, the media or middle, and the adventitia or outer. The intima is lined with endothelium, under which lies a layer composed of connective tissue and elastic tissue, and contain flattened cells like the nuclei of the cornea, with a branching system of channels. The media is mainly muscular; the adventitia fibrous. In small arteries there is relatively more muscle, in larger ones, more elastic tissue.

Functionally, the arteries are tubes which have some control of the circulation by their contraction or dilatation. This is influenced by the nervous system, certain nerves causing constriction (vaso-constrictors), certain others dilatation (vaso-dilators).

MORBID PROCESSES IN THE ARTERIES.

1. **Hypertrophy** is best illustrated in the establishment of collateral circulation, in which small vessels become at first distended, but later the seat of true hypertrophy of all the coats. Hypertrophy also follows increased pressure in the general circulation, as in one stage of arterial sclerosis.

2. **Atrophy** may occur in wasting diseases, or in any organ undergoing atrophy. Amputation of a limb furnishes examples of atrophy of the vessels in the stump. The middle coat especially is involved.

3. **Calcareous Infiltration,** or limy infiltration, is a common result of atheroma, following the sclerosis and fatty degeneration, as in the heart.

4. **Amyloid Infiltration** is not uncommon, the process of amyloid infiltration very commonly beginning in the blood-vessels.

5. **Fatty Degeneration** presents whitish spots, clearly seen in the intima. The process most frequently follows sclerosis, but may be caused by poisons, such as phosphorus, arsenic, chloroform etc. The connective-tissue corpuscles or the intercellular substance may be involved, and very commonly the muscle fibers of the media.

6. **Hyaline Degeneration** affects especially the intima of large vessels, all of the coats of the arterioles, and in the capillaries is seen outside the endothelium. The appearance is that of a glass-like or hyaline substance, which is, perhaps, produced by reaction between substances in the tissue and in the blood. Infectious diseases are the common cause, but hyaline degeneration may be the precursor of atheroma, preceding fatty degeneration. Stained wt. iodine.

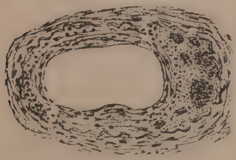
7. **Acute Suppurative Arteritis** may be the result of thrombosis, or may be due to extension of suppurative processes from the

neighboring parts into the vessel, though this is attended with some difficulty. may brave

8. Acute Productive Arteritis, variously called proliferative, formative or productive, resembles warty endocarditis. There is formation of fibrin (thrombus), the proliferation of endothelial and connective-tissue cells, formation of new blood-vessels, and finally complete organization and perhaps obliteration of the vessels. The last constitutes *obliterative endarteritis*. Such a result always follows in the smaller vessels. The process occurs in organs, the the seat of proliferative processes, or in areas of organs in which such are taking place; also as a result of lodgement of a *simple* embolus. It is typically represented in ligation of arteries. The intima being injured, all the phenomena of inflammation of a serous membrane are produced—fibrin formation, cell proliferation and exudation, and at the end of twelve days in experiments with dogs new blood-vessels are already formed. This process has been called *Thrombo-arteritis*. In the healing of wounds a somewhat similar process is observed. [illegible] is better

9. Arterial Sclerosis and Atheroma. Sclerosis of arteries presents a slow thickening of the intima, the result of chronic inflammation and is either *localized or diffuse*. The diffuse form occurs almost physiologically in advanced life, and is of moderate degree.

The *localized form* appears as patches of thickening of moderate extent and usually pathological. These swellings are at first whitish and translucent, but later undergo degeneration, become yellow and opaque—then constituting the so-called "Atheroma plate." Such processes are seen with especial frequency in the aorta, and are very rare in the mesenteric and in the pulmonary arteries. The latter may be affected when there is marked disturbance of the pulmonary circulation, but are not usually. The histology of the process includes:



1. Overgrowth from inflammatory proliferation of the cells of the intima with round-cell infiltration, etc. This process begins in the outer layer of the intima and thence extends.

2. There is next tendency to fatty and other degenerations and formation of the atheroma plates above mentioned.

3. Degeneration may proceed to complete breaking down, liquefaction and perhaps rupture into the vessel and consequent production of "atheromatous ulcer." On the other hand calcareous infiltration may occur or very rarely even ossification.

From the beginning it is evident that the proliferative-tissue tends to degenerate and to form the atheroma plates. In the early stages, before fatty degeneration has declared itself, there may be hyaline degeneration, cazeation, or myxomatous degeneration, and it is at this time that the translucent appearance is observed. Later the plates become yellow from fatty degeneration.

Causes. Certain predisposing factors as age (for the diffuse form), alcohol, syphilis, and rheumatism undoubtedly play a part.

In the very earliest stages of the process, before any anatomical lesions are demonstrable, there is increased elasticity of the vessel-walls, therefore functional, preceding organic changes. This may be proved by testing arteries without lesions from a body in which other arteries showed circumscribed patches. In such cases it is sometimes possible to demonstrate increased elasticity. The first anatomical alteration in the vessel is probably slight hypertrophy of the muscle to compensate for the lost elasticity.

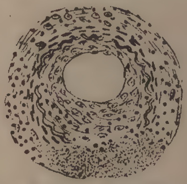
Now, it is plain that sudden distensions could more easily cause rupture of the intima in such vessels, and as a result proliferative changes would follow. That this is true, is proved by the fact that sclerosis is most common in vessels most subjected to such sudden distensions, as the small vessels of the aortic rather than the pulmonic circulation, or, in the brain, the small vessels springing from the circle of Willis, rather than those of the *pia mater*.

The order of frequency with which the different vessels are involved is as follows: arch of aorta, thoracic aorta, abdominal aorta, iliac, splenic, coronary, carotid, and the vertebral within the skull.

Results. Very commonly, valvular heart disease results. Rupture, especially of vessels of the brain. Aneurism, especially in the larger vessels, which are most weakened by the process. Thrombi may be formed at the seat of ulceration. The sclerotic process itself may cause narrowing and occlusion of the vessel. [illegible]

Clinical Results. If observations could be made in the earliest stages a softened, yielding condition of the arteries would be found, but such observations have never been made. The advanced stages only are observed, and there is more or less rigidity of the vessels, and the sphygmograph gives a definite tracing. In a normal vessel, the elasticity of the walls is such that rapid distension occurs and the lever of the sphygmograph is given a sudden impetus which carries it a little too high, and as a result there is again a sudden drop which gives rise to a sharp pointed tracing. In sclerotic vessels no such sudden rise of the lever occurs, it cannot overshoot its limit, and in consequence there is a flat-topped curve with a slanting instead of of vertical up-stroke.

10. Syphilitic Arteritis is an endarteritis, but is not characteristic. One peculiarity is to a certain extent diagnostic, viz.: the the great proliferation of endothelial cells without tendency to degeneration, that is, altheroma. In many cases, however, there are areas where degeneration and true atheroma do occur, but sometimes such is entirely absent, and on the contrary organization and formation of firbrous tissue are observed. The media and adventitia are simultaneously involved.



11. Tubercular Arteritis generally begins in the adventitia and travels inward, being, therefore, merely an extension from tuberculosis of the neighboring structures. There is tendency to early coagulation—and cheesy—necrosis, and in consequence we find cells which do not stain well—early in the case. Aneurismal dilatations may occur, and are the source of pulmonary hemorrhages. Generally affects one [illegible] the other.

12. Aneurism is generally the result of sclerosis. It may be defined as any localized dilatation in the arterial tree.

Forms. (*a*) Ectatic, (*b*) saccular, and (*c*) dissecting.

A. Ectatic Aneurisms present expansions, due to yielding of all the coats, and are, therefore, merely dilatations. According to shape there are: fusiform, which are spindle-shaped; cylindrical; and cirsoid, in which the dilatation is on different sides of the vessel alternately, with a resultant twisted or corkscrew-like deformity. The last occurs especially in the abdominal aorta.

B. Saccular Aneurisms may be classed as (*a*) true, in which the walls of the aneurism are formed by one or more of the arterial coats, and (*b*) false, when the arterial coats are not represented in the aneurismal sac, which is constituted by surrounding structures.

A. True Saccular Aneurism. An important variety is the *miliary* aneurism, which develops in the substance of certain organs. The small arteries branching from the circle of Willis and penetrating the basal ganglia and the terminal branches of the pulmonary arteries

(a) Miliary aneurysm [illegible]

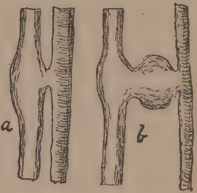
are the ones most frequently affected. Hemorrhage is the common result. In the brain they are found especially in the corpus striatum and in the area between this and the optic thalamus, largely because the arteries supplying these areas are branches of large vessels with high blood pressure. Miliary aneurisms in the pulmonary branches result from tubercular disease of the walls, and lead to pulmonary hemorrhages.

B. False Saccular Aneurism may be:

1. Simple when the aneurism results from a penetrating wound of the artery.

2. Varicose Aneurism, when the vein becomes the wall of the aneurism as a result of rupture of a previous aneurism, true or false, into the vein.

3. Arterio-venous Aneurism, when, as a result of injury to artery and vein, the blood from both pours into the cellular tissue and forms a false aneurism.



A. Aneurismal varix.
B. Varicose aneurism.

4. Aneurismal Varix, when as a result of a communication between artery and vein the blood passes from the former into the latter and causes it to dilate and hypertrophy. There is no pre-formed aneurism, as is the case in varicose aneurism.

3 **C. Dissecting Aneurisms** are such as do not remain localized to the point of rupture of the vessel walls but burrow between the planes of tissue, that is, between the coats of the vessel in case of rupture of only one or two of the layers, or between the surrounding tissues in case of complete rupture. Generally we mean by "dissecting" aneurism one in which the coats of the vessel are dissected, though sometimes it refers to a false aneurism burrowing between the planes of the surrounding tissue. Such aneurisms may be very extensive, as *e. g.*, involving the entire length of the aorta.

Causes. The most common cause of true aneurism is sclerosis of the artery, either primary or following disease-processes in the surrounding structures and of these notably tuberculosis. Embolism may be causative, especially in producing certain forms of "mycotic" or "parasitic" aneurism.

Traumatism is the most common of all the causes, but generally produces false aneurism.

Symptoms of aneurism are due to pressure, and as this may vary with greater or less distension of the sac, a curious variation in the severity of the symptoms is observed. [illegible]

Thrombosis may lead to the formation [illegible] in large arteries

Location in the order of frequency : aortic arch, popliteal, femoral, abdominal aorta, carotid, subclavian. This does not include the minute aneurisms so common in the brain. [illegible]

The age of occurrence is from 30 to 60, and the male sex especially is affected.

THE VEINS.

[illegible] as in arteries

1. Fatty Degeneration and **2. Calcification** may occur as in arteries, but are of less importance. **3. Sclerosis** is also more rare and comparatively insignificant.

4. Acute Inflammation or **Phlebitis** is not rare and may lead to serious results. It usually results from thrombosis (*thrombo-phlebitis*), and may give rise to embolism. Emboli in the lungs are nearly always due to thrombosis in the venous system. Occlusion of the veins may also occur from thrombo-phlebitis.

5. Suppurative thrombo **Phlebitis** may be caused by septic infection of a thrombus or by extension of adjacent suppurative processes, first to the adventitia and then to the intima. Pyæmia, or septic embolism, may result.

6. Varix. (*Varicosity*, *Palebectasia* or *Varicose Veins.*) These terms designate fusiform or cylindrical dilatations of the veins, similar to ectatic aneurisms in arteries. We see aggregations of distended, hypertrophied and tortuous vessels. At first there is merely a distention of the veins, next hypertrophy of the muscular coat, and finally of all the coats. In consequence the vein becomes dilated, thicker, and from increase in length also tortuous. New veins are also formed

Causes. Mechanical impediment to the venous circulation—(*a*) by disease of the dilated vein, as thrombo-phlebitis, (*b*) by pressure on the vein, as in diseases in the pelvic organs, notably enlarged uterus, or (*c*) by cardiac failure. Whatever local cause of obstruction there is, it must be aided by general impairment of venous circulation, since venous anastomosis is so free and collateral circulation so readily established. Below the bifurcation [illegible] vena cava

Seats. Varicosity occurs especially in dependent parts of the body—the abdomen, pelvis, limbs. The hemorrhoidal veins are the most frequent seat. "Hemorrhoids" are due often to obstruction to the circulation in the pelvis, often in the liver, as by cirrhosis. Sometimes particular veins are obstructed, as those of the labia in females, the spermatic in males, or those from the neck of the bladder.

Want of exercise a frequent cause

Phlebolites or small vein stones often form in these kinds of veins

The results may be (1) bleeding, (2) inflammatory processes in the walls or in the neighboring structures, and (3) chronic ulcers. & deformation The inflammatory conditions are the outcome of chronic stasis, and are prone to take on dangerous types because of the favorable soil offered for micro-organisms of sepsis and suppuration. Chronic ulcers of the legs, the result of varicosities, are termed "varicose ulcers," and present sclerotic bases and edges, dark colored and surrounded by skin of purplish hue. May [illegible] to phlebitis in

7. Tubercular and Syphilitic Processes may occur, but are unimportant.

8. Tumors easily involve veins of the neighborhood, as *e. g.* in cancer or sarcoma, but arteries resist and may remain healthy in the midst of a tumor.

CHAPTER VII.

THE RESPIRATORY ORGANS.

We study the pathology of the nasal chambers, the larnyx, bronchi, lungs and pleuræ.

THE NASAL CAVITIES.

1. Circulatory Disturbances are common. The submucosa is of the character called "erectile," especially in certain spots, as below the turbinated bones. *Congestion* of these areas may be the precursor of inflammation, but often is of a peculiar and obscure nature, probably dependent on certain nervous derangements. Such conditions affect some individuals by preference, appear at intervals and present swelling and engorgement of the tissues. Serious reflex disturbances may result, especially *asthma* and *persistent cough*, sometimes suggesting phthisis. The nasal mucous membrane has been thought by some to be as frequent a source of reflex disorders as the uterus.

Another result of engorgement is hemorrhage or *epistaxis*. This may be due to the above-described periodical engorgement about the turbinated bones, to passive congestion the result of heart disease, especially mitral obstruction; to vascular disease, as atheroma; or finally to blood diseases, like hæmophilia and scurvy.

2. Inflammation. Rhinitis. Coryza. There is general congestion of the mucous membrane, followed by exudation, at first sero-mucous, containing ciliated epithelium and a few leucocytes, later more and more purulent, until finally pure pus is obtained. The process may extend to the communicating cavities of the sphenoid, ethmoid or superior maxillary bones, or to the middle ear, and thus may produce serious symptoms. In other cases extension to the larynx and upper part of the trachea is noted.

Causes. Cold is considered the most frequent cause, but it is doubtful whether this acts as a cause at all. The early stage is characterized by sensitiveness to cold, which leads to the belief that cold was the cause. Cold may *predispose* by altering the character of the secretions, and thus prepare the membrane for the real cause, which is almost always an *infection.*

Suppurative Rhinitis is a form in which there is marked tendency to early suppuration, such cases being due to micro-organisms, which always produce suppurative inflammation, as the *gonococcus*, the *glanders bacillus*, etc. Again, there may be extension from suppurations near by, as from the bones.

3. Chronic Rhinitis tends to the production of connective tissue, hence the name *rhinitis hypertrophica.* The membrane is swollen, presenting quantities of new connective tissue, often projecting in tumor like processes and causing an appearance not rarely mistaken for polyps. There is at the same time always a certain amount of atrophy in patches, and sometimes extensive atrophic changes occur from retraction of the connective tissue. The secretions in these cases are purulent, decomposing and fetid, the disease being called *ozæna.* The deeper structures, cartilage and bone, are also affected to some extent.

4. Infectious Diseases. *Influenza* or *grip* has prominent manifestations in the nasal mucous membrane. The coryza of this disease seems unquestionably due to the action of a micro-organism, though at the same time certain atmospheric conditions are necessary to cause the disease to spread. In the absence of such conditions isolated cases or circumscribed epidemics are seen. *Measles* and *typhoid fever* also cause some coryza.

5. Chronic Infections.

Glanders, in the lower animals, runs an acute course, with localized foci of suppuration in the nasal mucous membrane, and ends in death. In man the disease is less apt to affect the nose, and is more chronic.

Syphilis may present condylomata; gummata, affecting the cartilages, bones, periosteum or perichondrium, and leading to extensive destruction; or, lastly, there may occur a form of *hyperplastic rhinitis*, terminating, like the simple form, in atrophy and ozæna.

Tuberculosis may present miliary tubercles or ulcers from the breaking down of cheesy foci. The latter are certainly much commoner than is generally believed, and, probably, careful examination would reveal tubercular ulcers in most of the chronic nasal catarrhs of scrofulous children. Tubercle bacilli have been found in the discharges. This, too, may be the source of the frequent cases of tubercular meningitis in children.

6. Tumors. (*a*) *Mucous Polyps* are a common form, but generally seem rather of the nature of inflammatory hyperplasia of the mucous membrane than true tumors. Not rarely such polyps are cystic from occlusion of some of the mucous glands contained in the hyperplastic mucous membrane, and sometimes the cyst may comprise the bulk of the tumor. Mucous polyps may then be: (1) true myxomata, a rare form, in which the connective tissue of the tumor is myxomatous; or (2) cystic, when, as above described, mucoid material collects, from myxomatous degeneration of epithelial cells in the glands of the hyperplastic mucous membrane. The most frequent *seat* is about the middle turbinated bone. The result may be obstruction of some of the sinuses or the nose itself, and sometimes protrusion externally, when the exposed surface becomes considerably altered by the action of dust and air. They are easily removed, but tend to recur.

(*b*) *Fibromata*, hard and soft, occur about the posterior nares and naso-pharynx. Often they spring from the roof of the pharynx, basilar process of the occipital and the sphenoid bones, and either extend into the posterior nares or hang from the roof of the pharynx.

(*c*) *Chondroma* and *Osteoid Chondroma* are rare, but occur most frequently in the sinuses.

(*d*) *Sarcoma* is found springing from the posterior parts of the cavity.

(*e*) *Carcinoma* is rare, and mostly arises from extension of epithelioma of the face.

THE LARYNX.

Anatomy. The mucous membrane presents two kinds of epithelium. The greater part is ciliated, but a considerable portion of the epiglottis is covered with squamous cells, with ciliated epithelium between. From this point as a center there are radiating lines of mucous membrane covered with squamous cells extending toward the vocal cords. The true cords themselves are covered entirely with squamous cells.

Malformations of the Larynx are rare. Sometimes the branchial arches of the fœtus fail to close, and fistula from the exterior to the larynx results, though this is rare, pharyngeal fistula more commonly arising. The larynx may be small or hypoplastic. Sometimes the ventricles are enlarged, constituting a condition called "Emphysema of the Neck."

MORBID PROCESSES.

1. Circulatory Disturbances.

(*a*) *Active Hyperæmia* is found in the early stages of inflammation. It must be remembered that the congestion is invisable after death, the elastic tissue contracting and squeezing the blood out.

(*b*) *Passive Hyperæmia* is found in the stasis of heart disease, etc.

(*c*) *Minute Hemorrhages* in the mucous membrane occur in severe inflammations, as in the acute and fatal catarrhal inflammations in children. In death from suffocation and in hemorrhagic diseases we may also find laryngeal ecchymoses.

(*d*) "*Œdema of the Glottis*," a serious, often fatal, condition, is not purely œdema, and does not occur in such cases of Bright's disease in which we may expect only pure œdema. It is an inflammatory manifestation.

2. Inflammation or **Catarrhal Laryngitis** is more common in children than adults. It presents swelling and congestion of the mucous membrane, desquamation of cells, and sometimes "erosions," but not deep ulcers. At times it is confined to the follicles, constituting "follicular laryngitis," in which the enlarged follicles stand out against a swollen and reddened base. They may break down and form deep ulcers, into which a probe may be inserted some distance. The epiglottis and ary-epiglottic folds are the favorite seat for this form..

3. Infectious Diseases. *Measles*, *Small-pox* and *Typhoid Fever* all cause laryngeal inflammation in some cases.

4. Chronic Laryngitis presents a thickened mucous membrane with enlarged blood vessels, often papillomatous outgrowths, and in general that warty condition called "pachydermatous change." Later in the case, contraction may occur, with atrophy and destruction of the mucous membrane and its substitution by cicatricial tissue. Various deformities may be produced, with disturbance of the speech or respiration.

5. Croupous Laryngitis is such as is characterized by fibrinous exudate. Sometimes the process occurs by extension from the pharynx, or more rarely the trachea. Often the deposit is localized in patches or confined to the venticles, but in other cases complete casts of the larynx may be observed. It may be easily removed, except in parts covered by squamous epithelium, where the process seems to extend deeper. The membrane is of a buff to a brown color, and consists of a fine network of fibrin (or granular or homogeneous masses of fibrin), holding in its meshes many loosened epithelial cells of the larynx, largely altered by coagulation necrosis, and outwandered leucocytes. Sometimes there is a marked stratification from excessive proportion of one or the other element (epithelial cells, leucocytes or fibrin) in the different layers.

In the larynx the process is confined to the epithelial layer, and on removal of the membrane no marked lesions are observed—only here and there tendency to small hemorrhages; but in the pharynx deeper involvement is observed.

Causes. A great variety exist, and in the lower animals the process may be produced by irritants; but in man, in most cases, it is the bacillus of diphtheria. Therefore, *most cases of croup are merely diphtheria of the larynx.* Such cases usually occur from extension from the pharynx, are epidemic, and by inoculation animals may be infected.

Diphtheria is a specific disease due to a micro-organism, the *Klebs-Loffler bacillus*, which is about as long as the *tubercle bacillus*, but often twice as thick. It is characteristically irregular, presenting great abnormalities. On staining, the bacillus is often seen to be broken up into a chain of fragments, and one or both ends may be bulbous and more deeply stained than the rest.

Demonstration. Take a half dozen or more tubes containing glycerine-agar. Remove a piece of the diphtheritic membrane and rub it on the surface of the agar in one tube ("original tube"). With a sterilized wire remove a portion of the infected agar of the "original tube" and inoculate a second tube ("tube No. 1"). Continue in successive tubes until six or more are inoculated. Place in an incubator at 37° C. The most successful growths are obtained in the last inoculated tubes, because in the first the growth is so rapid that the individual colonies run together. When the growth is obtained, portions may be spread on cover glasses, stained and examined.

The diphtheria bacillus is always found locally, never in the blood, and the process is, therefore, always a local one. The general manifestations of the disease are due to the production of certain *poisonous albuminous substances* which enter the circulation. These may be isolated, injected into animals, and the disease so produced. The paralyses after diphtheria are due to multiple neuritis, caused by the action of these poisons; and in animals injections of these substances sometimes cause such paralyses.

The poison produced by this bacillus, like some other pathogenic bacteria, or else something elaborated at the same time as the poison, has protective influences, and animals inoculated with such are for a certain time immune. This fact has not been sufficiently developed to furnish any method of treatment as yet.

6. Inflammation of the Submucous Tissue. "Œdema of the Larynx." This is naturally most marked where this tissue is most abundant. Such is found under the loose mucous membrane of the ary-epiglottic folds and at the base of the epiglottis. The swelling is most marked at these points. "Œdema of the larynx" is very rarely pure œdema, but usually inflammatory, sero-purulent or entirely purulent. In the last case we have *abscess* of the larynx, which occurs at the base of the epiglottis, in the aryteno-epiglottic folds, and sometimes in the ventricles.

Causes. Most frequently extension from neighboring structures, especially the larynx itself. Chronic laryngeal ulceration, particularly tubercular, is the commonest cause of acute sero-purulent inflammation of the sub-mucosa. Erysipelas may extend from the face downward to the larynx, and the inflammation from a retropharyngeal abscess may extend around.

7. Perichondritis is inflammation of the perichondrium, and is mostly due to extension from adjacent inflammations, as tubercular ulceration, the commonest cause, or syphilitic ulcerations, syphilis having a decided tendency to involve the perichondrium here as elsewhere. The process may, rarely, complicate typhoid fever.

The *results* are necrosis of the cartilages and their perforation, the discharge of fragments, which may fall into the larynx and cause death by obstructing the trachea.

8. Tumors. (*a*) *Papillomata* constitute 70 per cent. of all the tumors. They are quite common, but are rather inflammatory hyperplasias than true tumors. Two varieties are described, the *hard* and the *soft*. In the former we find hard, warty excrescences, showing hypertrophy of the papillæ and thickening of the epithelial covering constituting a "pachydermatous" condition. In the soft papilloma an appearance like that of the "acuminated condyloma" is produced, a dendritic outgrowth without much hyperplasia of the epithelium. The hyperplasia affects mainly the papillæ with only a thin layer of epithelium.

Papillomata occur especially about the true vocal cords, but may extend upward to the epiglottis, and also somewhat downward; for they have a tendency to cause "squamous invasion"—that is, to induce changes of the surrounding epithelium to the squamous variety. These growths often result from repeated irritations, such as are caused by smoking, speaking, or alcohol, or they may be found about the borders of chronic ulcerations.

(*b*) *Fibroma* or *Fibrous Polyp* may be hard or soft, and occurs most frequently on the vocal cords, in the ventricles, or at the base of the epiglottis. These growths are more apt to be single, but, like papillomata, may sometimes present multiple excrescences.

(*c*) *Myxoma* may be the result of myxomatous change in the *connective tissue* of a tumor, but in other cases may be cystic, from degeneration of the epithelial cells in glands included in the hyperplastic mucous membrane constituting papillomata.

(*d*) *Sarcoma* is rare, but the spindle-celled sometimes springs from the epiglottis.

(*e*) *Carcinoma* is not rare, and usually is of the squamous variety, growing from parts covered with squamous epithelium; often, also, by extension from the tongue, œsophagus, and other neighboring parts. Papillomatous excrescences may surround the cancer, and cause mistakes in diagnosis.

9. Tuberculosis does not differ materially from the same disease elsewhere. There may be miliary nodules or cheesy foci, breaking down and leaving ulcers. The latter may be (*a*) isolated and superficial, or deep into the connective tissue and down to the cartilages; or (*b*) they may be numerous. The distribution of the ulcers is to a degree distinctive, beginning below and traveling upward whereas syphilitic ulcerations start above and extend downward. There is, however, a very exceptional form of tuberculosis, which travels downward, viz., lupus, beginning on the face and extending to the mouth, epiglottis and larynx. Furthermore, the position of the ulcers in the larynx itself is somewhat characteristic. During the day the secretions are not allowed to remain long in any part of the air tubes, but at night they rest in the bronchi and trachea, and, from the recumbent position of the patient, on the posterior wall of these. In consequence, the first ulceration is on the posterior wall of the larynx, trachea and bronchi, whence the process may extend around. If only one ulcer be found, it will probably be seen posteriorly between the arytenoid cartilages.

After the ulceration various more destructive processes occur.

Primary Tuberculosis of the larynx is very rare and always doubtful. It probably never occurs.

Many cases tend to recover, as was well seen during the Koch-cure excitement. Under this treatment ulcers frequently healed, but broke out in other places.

10. Syphilis of the larynx may present (*a*) flat condylomata or mucous patches; (*b*) true gummy tumors, deep-seated in the connective tissue; or (*c*) simple inflammations. The syphilitic ulceration is apt to extend from the pharynx, affecting the epiglottis first and most prominently. The lesions are more deeply seated than in tuberculosis, and, unlike the latter, tend to form cicatricial tissue, and cause distortions of the larynx.

THE BRONCHIAL TUBES.

Anatomy. The bronchial tubes are a system of tubes lined within with a mucous membrane, and consisting of connective tissue containing cartilage plates, smooth muscular tissue, and elastic fiber, the latter especially abundant where the cartilage rings or plates fail to complete the circumference. In the larger bronchi the cartilages are rings, incomplete posteriorly, where abundance of elastic tissue makes up for the lack of cartilage.

The epithelium of the mucous membrane is columnar and ciliated down to the smallest branches, just before these open into the dilated pouches, *the infundibula*, from which the air vesicles spring. In these terminal bronchioles the epithelium loses its cilia and becomes cuboidal, and as we pass on to the infundibula and air vesicles finally becomes flat and tesselated.

In the larger bronchi there are numerous racemose glands, imbedded in the mucous membrane, and visible to the naked eye on the surface.

MORBID PROCESSES.

1. Hyperæmia may be active or passive, the former occurring in the early stage of inflammation, the latter as a result of disturbances of the general or pulmonary circulation, notably from heart disease.

2. Acute Bronchitis produces intense engorgement of the mucous membrane, which is swollen, opaque, and presents punctiform hemorrhages. The racemose glands, visible normally, may be hidden from view, or in rare cases may be specially inflamed, causing *follicular inflammation*.

The exudation is at first thick and tenacious, but later becomes more liquid and, from admixture of pus, yellowish in color. Occasionally there may be true pus; in other cases the exudation is very liquid and copious, when we speak of *Bronchorrhœa*, either *serous* or *purulent*, according to the character of the exudation.

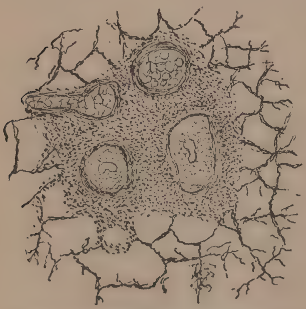
Microscopically, there is seen cellular infiltration, often very dense at the base of the epithelial cells, which are in consequence discharged. When there are several layers of epithelial cells, the ciliated may be shed, leaving a surface of cuboidal or squamous epithelium, or sometimes none at all.

The *result* is usually recovery, but if the cause be persistent, or if there be chronic circulatory disturbances, as from heart disease, a more chronic course follows. There may be several results: (1) The mucous membrane becomes thickened, hypertrophied and exceptionally presents papillomatous excrescences, with constant serous or purulent discharge. (2) When the case is persistent atrophy occurs, with disappearance of the mucous membrane, elastic fibers and even the muscular tissue, such results being more common in advanced life.

3. Croupous Bronchitis may of course be the result of extensions of a croupous laryngitis, but there is another form in no way connected with diphtheria. This is a special disease which comes on paroxysmally in certain persons, otherwise in good health; is characterized by obstruction of the bronchi, great dyspnœa, and, after a course of four or five days, by expectoration of fibrinous membrane, sometimes representing casts of the bronchial tubes, and relief of all the symptoms until a subsequent attack. The disease is in no sense diphtheria, but rather like asthma. Indeed, some cases of asthma may be merely "fibrinous or croupous bronchitis" affecting the terminal bronchioles. The casts may be visible to the naked eye, but many are microscopical, and they may carry *in their substance* Charcot-Leyden crystals, those peculiar crystals found in leucæmic blood, and *free* in asthmatic sputum. Moreover, in the expectoration of these cases may be found cells containing granules, which, like the granules of certain of the leucocytes in leucæmia, stain well with eosin.

4. Chronic Bronchitis may arise in several ways: (1) From repeated attacks of acute bronchitis—and in these cases no great change of appearance is seen; (2) from disturbed pulmonary circulation; and (3) from tuberculosis. Disturbed pulmonary circulation is a very common cause, and explains the frequency of the disease after forty or fifty years, for one of the first signs of advancing years is such circulatory failure, as evidenced by the "loss of wind."

Tuberculosis is a common cause which is often overlooked. The lesions are the same as those seen elsewhere: miliary nodules or tubercular ulcers, while there is, in other cases, simply a chronic catarrhal process, with desquamation and accumulation of cells and very little fluid—therefore a "dry" lesion. The tubes become filled with desquamated cells, the mucous membrane with proliferated ones, and in consequence cheesy necrosis ensues. Tuberculosis of the lungs may follow, and very often phthisis does have this origin. First the wall of the bronchus is disorganized, and next the surrounding tissues—"tubercular peribronchitis." It is important to recognize these cases in which the tubercular process began in the bronchi, or in which the bronchi are especially involved, at autopsy. On careful examination of the cut surface of the lung little projecting masses will be observed, and in their center openings, which are the bronchial tubes. The walls of the tube are thickened by the inflammation (bronchitis) and the mass further enlarged by the peribronchial infiltration. Later coagulation necrosis, cheesy change, and finally soften-



Bronchitis and Peribronchitis.

ing and formation of cavities may ensue; while in other cases the peribronchial hyperplasia tends to organize, constituting *Fibrous Peribronchitis*. The last may occur in tubercular cases, and phthisis with tendency to cure is often of this nature.

5. Suppurative Peribronchitis occurs by extension of purulent inflammation along the lymph vessels which lie around the bronchi. The process most frequently extends from the pleura in cases of empyema, or even, occasionally, acute pleurisy. This condition cannot be determined during life, but is discovered at autopsy.

Narrowing and closure of the bronchial tubes may be due to the secretions of the mucous membrane itself. Such acute obstruction leads to (1) atelectasis or (2) catarrhal pneumonia in the obstructed area.

6. Atelectasis, or collapse of the lung, is brought about as follows: The blood in the obstructed area, not being properly aerated, becomes overcharged with carbonic acid gas, and, as there is always a resistance in the vessels to the passage of blood of abnormal character, stagnation occurs. The air of the air vesicles is completely absorbed, and collapse results. There may then be further engorgement, and, perhaps, catarrhal pneumonia, or hemorrhage.

7. Obstruction of the Bronchi occurs in chronic bronchial affections, and may lead to atrophy of the air vesicles. Obstruction may also be due to foreign bodies, lodging especially in the right bronchus, or to pressure of mediastinal tumors, particularly aneurism.

8. Dilatation of the Bronchi, or **Bronchiectasis,** may be (*a*) cylindrical, or (*b*) saccular. Two factors enter into the causation: (1) Some weakening of the tube, most frequently from chronic bronchitis, and (2) a distending force.

If the weakening is uniform, cylindrical dilatation results, and such occurs especially in the lower lobes; if localized, we see sacculated dilatation, and this involves particularly the middle lobe.

As to the distending force, several theories are advanced, and each has some truth in it: (1) Some believe that the expiratory efforts in coughing, etc., with obstructed tubes, furnishes the distending force, while (2) others hold that forcible inspiratory efforts, resisted by a portion of the lung not readily expansible, causes the distension.

Bronchial dilatation may occasionally be due to diseases of the lungs, accompanied by formation of connective tissue which, contracting, pulls on the bronchial walls and so dilates them. Tuberculosis, by weakening the bronchial wall, is also a cause.

The *results* of bronchiectasis are accumulation and decomposition of secretions in the tubes, with resulting ulceration of their walls, fetor and perhaps gangrene of the lung.

THE LUNGS.

Anatomy. The bronchial tubes by a system of dichotomous branching become smaller and smaller until they finally terminate in pouches called the *infundibula*, from which spring the air vesicles. The terminal bronchioles, which lead into the infundibula, are called the *air passages*, and each of these communicates with 3, 4 or 5 infundibula. This constitutes an *acinus*, and finally ten or fifteen such acini constitute a *lobule*, which is supplied by a single bronchial tube.

The epithelium of the bronchial tubes is ciliated columnar; in the air passages it becomes deprived of its cilia; and finally in the infundibula and air vesicles is composed of flat, squamous cells with irregular outline, *very closely resembling endothelial cells.* The air vesicles contain in their walls loops of blood vessels, held together by connective tissue containing many elastic fibers. The blood vessels are separated from the air of the vesicles only by the flat endothelial cells, and since such walls separate adjacent vesicles the blood is exposed to the air on two sides.

Malformations. The most common is deficiency of part or the whole of one lung. This is usually accompanied by defect of the diaphragm and the presence in the thoracic cavity of the abdominal viscera.

MORBID PROCESSES.

1. Active Hyperæmia.

(*a*) One form is due to active exercise, running, rapid breathing, etc. This causes engorgement of the lung, sometimes hemorrhage or "pulmonary apoplexy," and occasionally sudden death. The organ is red, swollen, œdematous and of greater consistency than normal.

(*b*) Another form is caused by nervous lesions, especially of the medulla and pons, more rarely of the cortex. In the latter case the pulmonary congestion may be on the opposite side from the brain lesion. In lesions of the pons and medulla the hyperæmia is irregularly distributed on both sides.

2. Hypostatic Congestion is due to disordered pulmonary circulation, and especially failure of the right heart. As a result, the vessels become relaxed and overfilled with bood. This might be looked upon as a form of passive hyperæmia, but is really midway between active and passive. It occurs in the dependent parts of the lung.

3. Atelectatic Hyperæmia is brought about by obstruction of a bronchus, and occurs in the obstructed area. It is due to the fact that the blood in this area becomes overfilled with carbonic acid gas, and therefore does not readily flow out of the part.

4. Embolic Hyperæmia. The congestion in an area obstructed by an embolus may not be sufficient to cause hemorrhagic infarction, and remains as a congestion until it is relieved.

5. Passive Hyperæmia is most frequently due to cardiac insufficiency, to left-sided heart disease, whereby the lung cannot empty itself of blood. Various appearances result, but there is nearly always **Œdema,** the lung being enlarged and filled with serum, which lies both in the vesicles and in the interstitial tissues. On pressure the serum exudes as a frothy fluid. More rarely, passive hyperæmia may appear as a *dry hyperæmia ;* that is, without œdema. In some cases the lung tissue retains its normal retractility, and by the aid of respiratory efforts overcomes the hyperæmia, and œdema does not result. We might speak of "pulmonary sufficiency" in such cases. On the other hand, the elasticity may be lost and the muscular efforts may alone be active to empty the air vesicles of air. In such cases œdema would supervene, and we speak of "pulmonary insufficiency." The latter process is sometimes localized in small areas, which becomes œdematous.

Results. Passive hyperæmia may disappear and leave no results. In other cases minute hemorrhages may occur by rupture, or more frequently by diapedesis. Such hemorrhages occur both in the air vesicles and in the tissue, with resultant deposition of hæmosiderin. In the air vesicles this pigment is taken up by the cells lining the air vesicles or wandering cells, and such pigment-laden cells are abundant in the expectoration of cases of heart disease. In some cases the intensity of the congestion, or more often the repetition of such, brings about hyperplasia of the connective tissue of the lung, which, with the pigmentation, causes an appearance called "Brown Induration." Sometimes the distensions of the veins causes a marbled appearance of the lungs.

Spenization is a condition of more intense engorgement than is seen in ordinary cases of œdema. Instead of a frothy liquid a hemorrhagic serum exudes from the cut surface. This fluid contains numerous blood corpuscles, both white and red, from diapedesis. The organ is smooth on section, dark colored and of the consistency of the spleen. A common result is inflammation, affecting the dependent parts of the lung, whence the name "hypostatic pneumonia."

The congestion alone could not produce inflammation, but makes the lung a favorable soil for micro-organisms. Hypostatic pneumonia frequently develops at the approach of death, or under circumstances similarly predisposing to "aspiration." The proper function of the ciliated cells not being performed, noxious substances like micro-organisms are inspired and carried to the deepest parts of the lungs by aspiration. Hypostatic pneumonia is very commonly called "Aspiration Pneumonia" by the Germans.

6. Hemorrhage. Accumulations of blood may be found in the lungs when the hemorrhage really occurred higher up, as from rupture of an aneurism into the trachea or bronchi.

(*a*) Hemorrhage may occur in the various hyperæmias, or in the early stages of inflammation or pneumonia from diapedesis.

(*b*) Traumatism as in penetrating wounds or crushing injuries may cause the hemorrhage.

(*c*) Tubercular hemorrhages are most frequently from the walls of cavities. The walls of the vessels become eroded by the tubercular process, and small aneurisms result. These rupture and so give rise to hemorrhage. However, the walls of blood vessels for some time resist the process, though eventually they give way.

But sometimes hemorrhages occur before any advanced disease processes have appeared in the lungs, and there is a popular belief that they bring on tubercular processes. Such hemorrhages are either (1) accidental hemorrhages in persons of tubercular tendency, and followed by development of the disease from other causes, not at all dependent on the hemorrhage, or (2) they may be due to slight and almost latent tubercular lesions, just as a minute and unrecognized gastric ulcer may cause copious hemorrhage.

(*d*) Vicarious hemorrhages are such as are due to suppression of hemorrhage elsewhere, as *e. g.* menstruation, or rarely the bleeding of hemorrhoids.

(*e*) Cerebral lesions may produce hemorrhages as well as congestions. Lesions of the pons and medulla are the most frequent forms, but traumatic lesions of any part may produce the hemorrhages, which are of the nature of infiltrations rather than external hemorrhages.

7. Hemorrhagic Infarction is due to obstruction of a branch of the pulmonary artery or vein or of a small bronchus. Most frequently one of the arterial branches becomes occluded, the obstruction being due to plugs of fibrin. These are mainly formed at the point of obstruction; that is, they are thrombotic, but in some cases of endocarditis of the right heart the obstruction may be entirely embolic, and in the cases where thrombosis is present there was probably an embolus or multiple emboli, which, though incapable of occluding a vessel themselves, cause clotting of the blood and thus obstruction. Such emboli (generally pyæmic) come from the venous system and especially the portal circulation. They pass harmlessly through the liver, and would doubtless also through the lung if they did not in the slowed circulation there cause thrombosis. There is then a mixture of thrombosis and embolism.

The *hemorrhagic infarct* is a circumscribed area of extravasation of conical shape, the base toward the pleura, the apex toward the root of the lung. On the pleural surface the dark red patches are readily distinguished, and on section through the lung the triangular section of the engorged, infarcted area stands out from the pulmonary tissue, which collapses as soon as cut.

In some cases thrombi are found in the pulmonary veins, and not in the arteries.

In still other cases it is the bronchi that become occluded, areas of engorgement result as in atelectasis, and the congestion may be relieved by hemorrhage. Such infarcts are indistinguishable anatomically from the others, except by the absence of occlusion of the blood vessels. The area is of the same shape, for the bronchus divides just as do the vessels. Possibly such infarctions are commoner than is generally supposed, and occasional failure to find lesions in the venous system in cases of hemorrhagic infarction of the lungs may be due to this fact.

Results. (1) If the infarction is slight absorption may occur, first the plasma and after that the detritus from broken-down red corpuscles. The lymphatics are filled with pigment, as also the leucocytes wandering away, but much pigmentation may remain in the walls of the air vesicles for years. The expectoration may be loaded with cells containing pigment. Such is the most favorable termination.

(2) In other cases localized areas of induration with pigmentation may mark the site of infarction, and this, too, is a favorable outcome.

On the other hand, untoward results may occur. If the original embolus was specific, containing organisms of suppuration, a localized area of suppuration would result. Such emboli are small, and occlude such small vessels that if they were not septic emboli little harm would follow. But in such cases there was not truly a hemorrhagic infarct.

(3) A hemorrhagic infarct may, however, become infected, and in consequence a wedge-shaped abscess results. In such cases the micro-organisms gain access through the circulation or the bronchial tubes. Considerable destruction of pulmonary tissue results and scars mark their site.

(4) When "saprophytic" bacteria (such as cause putrefactive decomposition) infect the infarct *gangrene* is the result. There is rapid destruction of the area, leaving a cavity with gangrenous walls. Rapid death is the usual result, but recovery and cicatrization may occur.

Seats. The right lung is more frequently affected than the left, on account of the anatomical arrangement of the arteries, and for similar reasons, perhaps, the lower and middle lobes more often than the upper, though here the fact that engorgements are more likely in the lower lobes is also operative. Scars at the apices usually indicate tuberculosis. Scars at the bases and in the middle lobe make us suspect past infarctions.

8. Inflammation or Pneumonia are terms which designate all those processes that are characterized by the presence of inflammatory products in the air cells, such being the result of exudation or proliferation.

Several varieties are described :

(1) *Fibrinous or Croupous Pneumonia.*

(2) *Desquamative Pneumonia*, a form characterized principally by desquamation of the flat endothelial cells lining the air vesicles.

(3) *Catarrhal Pneumonia*, a form not usually distinguished from the last, but in which the air vesicles contain, in addition to the desquamated cells, some fluid and leucocytes.

(4) *Purulent Pneumonia*, in which pus fills the air vesicles and infiltrates the lung tissue.

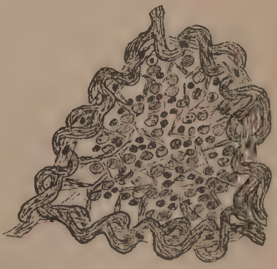
(5) *Caseous or Cheesy Pneumonia*, which, in the great majority of cases, is only an advanced stage of the desquamative form. The desquamated cells tend to undergo coagulation and then cheesy necrosis. There is at the same time decided involvement of the connective tissue between the air cells, showing round cell infiltration and epitheloidal cells. Finally, the entire masses, the portions inside and those outside the air vesicles, undergo cheesy change.

(6) *Interstitial or Productive Pneumonia*, the prominent feature of which is the proliferation of connective tissue and formation, first of embryonal, then of fully developed connective tissue, and finally contraction of the latter.

Croupous or Fibrinous Pneumonia, better called **Lobar Pneumonia,** for it has no relation to diphtheria or croup, is a form of inflammation of the lung characterized by exudation and fibrin formation in the air vesicles. Some have claimed that it is not an inflammation, but we shall see that it presents all the phenomena of inflammation. There are three stages:

1. *Stage of Engorgement or Congestion.* The capillaries of the intervesicular septæ are distended and bulge into the air vesicle, and the lung tissue is in a condition of inflammatory œdema, the vesicles being full of serous fluid, some red corpuscles which escape by diapedesis and loosened endothelial cells from the lining of the air vesicles. These loose cells, as also those still in the wall of the air vesicle, show evidences of active proliferation. Soon the exudate undergoes coagulation necrosis, just as happens in inflammations of serous surfaces, and we get—

2. *Stage of Consolidation or Red Hepatization.* The air vesicles are now filled with the products of coagulation necrosis: plugs of fibrin enclosing red corpuscles and endothelial cells not much altered by the necrosis.



The lung does not collapse on opening the chest, and is actually enlarged; it is heavy, sinks in water, is hard but fragile, and easily broken with the finger. The color is a dark red from the capillary engorgement and the hemorrhages into the air vesicles. On section a dry, granular surface is exposed, the granulation being due to projection of plugs of fibrin. By scraping the surface and examining with the microscope these fibrin masses may be found, and contain blood corpuscles and endothelial cells. The pleura over the affected area is also inflamed, whence the name "pleuro-pneumonia." The inflammation of the pleura is of the same nature as that of the lung, characterized by fibrin formation. There is always at least a thin film of fibrin, but at times the pleurisy is marked and may dwarf the pneumonia. Gradually the second stage passes into the—

3. *Stage of Gray Hepatization*, in which the leucocytes, which from the very first have been wandering into the air vesicles, become prominent and push the endothelial cells against the walls. It is apparent that there is no sharp distinction between the several forms of pneumonia, since the lecuocytes become so numerous in the late stages of croupous pneumonia as to approach a suppurative form, and in the early stage the endothelial cells suggest desquamative pneumonia. The lung in this stage presents the same appearances as in the stage of red hepatization, except the difference in color. This is due to the increased number of leucocytes, to the removal of the red corpuscles by expectoration or destruction and absorption, and to the fact that the increasing exudation presses upon the blood vessels and lessens their distension. In some cases there is actually anæmia. The color is therefore gray, or often, especially in adults, "granitic." In children the color is more often uniform, becoming yellowish.

Resolution is accomplished by continuation of the processes, the exudate undergoing liquefaction, and absorption in emulsion. The lung is still gray, but on section smooth and more moist, a pus-like fluid exuding from the cut surface. This has been erroneously called "purulent infiltration." It is simply an emulsion containing fatty elements and some leucocytes, but not a great number, and no micro-organisms of suppuration.

Toward the end of the process we again see evidences of proliferation of endothelial cells, as in the first stage. These cells may be in the fluid or in the walls, and their purpose now is to regenerate.

Other Terminations. In place of resolution there may be—(*a*) Fibrous change, in which the same changes occur as elsewhere in regeneration. The cells of the air vesicle walls sprout into the fibrin-mesh inside the vesicle, just as occurs in blood-vessels in organization of thrombi. Later on new connective tissue is formed, and is seen in the vesicle and in its walls. The lung is said to be "carnified," a name also applied to a compressed lung. There is really fibrous pneumonia. Such conditions are very rare, and may remain indolent or may cause retraction and puckering.

(*b*) Gangrene and abscess are more common than the above, but are very rare. They are due to the accidental infection with bacteria of putrefaction and suppuration respectively, the pneumonic lung being a favorable soil.

Seats. Over 50 per cent. of cases of lobar pneumonia affect one lower lobe, especially the right. It is rare to find the process localized at one apex. We may occasionally find different portions of the lung at different stages of the pneumonia, the lower lobes being generally most advanced "Wandering pneumonia" is the form in which such migration of the process occurs. It seems to be in some way associated with erysipelas (Guitéras).

Ætiology. The cause of lobar pneumonia is undoubtedly the "pneumococcus" or "diplococcus" of Frankel. It is not a coccus, but a bacillus of lanceolate shape, with pointed ends, and occurring by twos, or sometimes as a chain or streptococcus, in which case the individuals may be rhombic in shape, or more nearly spherical. It is a capsulated organism, the capsule being seen only when the organism has grown in the human body. The pneumococcus may be stained by Gram's method, and so distinguished from a similar organism also occasionally found in pneumonia, the bacillus of Friedlander, which is decolorized in Gram's method.

Cultivation of the pneumococcus is difficult. It is a delicate organism, and tends to lose its virulence. Very often the second culture has lost the virulence, and may even refuse to grow further. Grown at 37° C., a thin film may be seen on the agar, and minute droplets appear in Petri dishes; but these appearances are not characteristic.

Pathogenic Properties. In certain animals—guinea-pig, rabbit, mouse—the pneumococcus is a most virulent germ, producing septicæmia and not pneumonia when injected. After inoculation the animal soon presents enlarged spleen, high fever, other symptoms of general septicæmia and rapid death. It was therefore difficult to prove the pathogenicity of the germ, but finally it was found that when injected into the trachea in bouillon-culture, pneumonia could be induced. Next it was found that the pneumococcus rapidly loses virulence by successive cultivation, or when cultivated at different temperatures. Thus, when grown at a temperature of 41° or 42° C., it soon loses virulence as far as producing septicæmia is concerned, and now on injection produces only pneumonia. In man there is usually pneumonia, probably because of its introduction by the trachea, or because of changes in the organism itself, or because man is not susceptible, for it is a general rule that micro-organisms produce general disturbances in susceptible and local in unsusceptible animals.

Place of Occurrence and Frequency. In 90 per cent. of cases of croupous pneumonia the pneumococcus may be found in the sputum, or in scrapings of the lung at autopsy. In the other 10 per cent. it fails, probably because the organism has disappeared, for we know of its early disappearance from the fact that in the later stages it is scarce in the sputum. In the lung itself the diplococcus is found in the exudate in the air vesicles, and also in the tissues of the air vesicle walls. Exceptionally it occurs in the blood, when pyæmia results. Endocarditis, meningitis, pericarditis, inflammations of the middle ear and joint inflammations are all occasionally caused by the micro-organism. The pneumococcus in these cases may be the only organism found, and is not accidental but causative. These diseases being suppurative, the diplococcus must be regarded also as a pus-producing organism.

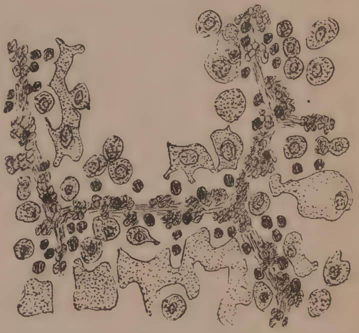
The pneumococcus occurs *normally* in the saliva, and was first discovered there by Sternberg. Its nature was at first not recognized, because on injection into animals, septicæmia and not pneumonia resulted. It is interesting to know how we escape pneumonia with the organism in the saliva, but only suppositions are possible at present. It is known that the saliva removes the virulence or kills certain bacteria, and perhaps acts so here; again it may be that, though still pathogenic for animals, it has been so altered as to be harmless to man.

Immunity may be produced in certain animals—guinea-pig, rabbit, mouse—by injecting products of the micro-organism. The juices are expressed from the organs of an animal which died with the septicæmia produced by the pneumococcus; this is filtered to remove all bacteria; precipitated by reagents, and the precipitate used for injection.

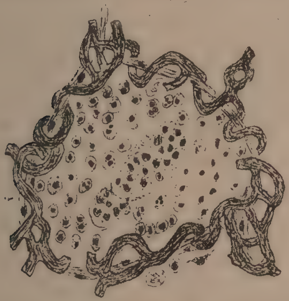
Cold certainly acts as a predisposing cause, but cannot alone produce the disease. It may be that the cold so alters the saliva that the germ becomes virulent.

Pneumonia is undoubtedly contagious to a slight extent, and epidemics have been noted. Dr. Guitéras himself observed two epidemics, in one of which the disease spread in a hospital from case to case.

Catarrhal, Tubular or Lobular Pneumonia is, like croupous pneumonia, characterized by exudation into the air vesicles of albuminous fluid containing red and white corpuscles and endothelial cells; but, unlike croupous, there is little fibrin formation, and, unlike ordinary catarrhal processes, little mucus is present. To the ordinary examination the liquid of the exudate is not apparent but may be demonstrated by plunging the lung into boiling water, when the albuminous fluid is coagulated.


Catarrhal Pneumonia, showing endothelia cells and outwandered leucocytes.

Catarrhal pneumonia is a lobular process, but in some cases a whole lobe may be full of scattered foci, or, more rarely, by confluence a whole lobe may be involved. In the last case, however, the lobular nature is evident from the different stage of the process in different lobules. There is the same intense engorgement of blood-vessels, and on microscopic examination the same knotted, distended capillaries are seen projecting into the air vesicles. On examination of the pleural surface there are seen dark purplish or slate-colored, perhaps sunken, patches of atelectasis, other lobules of healthy color and more elevated, and still others light grayish in color. If the lung is pressed between the fingers hard nodules may be felt—the indurated lobules. On section the lung is always smoother and more moist than croupous pneumonia. The diseased surrounded by healthy lobules are distinguishable—some red, intensely congested, others dark, atelectatic, and still others beginning to become gray. On pressure frothy, œdematous fluid flows from the healthy lobules, and from the diseased a thicker, grayish-yellow puriform liquid, which contains a large number of cells undergoing fatty degeneration. A few lobules, especially near the



periphery of the diseased area, show fibrin in the air vesicles. The center of a diseased area is always farther advanced than the periphery.

Varieties. Anatomically all forms are alike, but not ætiologically.

1. *Atelectatic.* The engorgement of atelectasis may go on to actual inflammation—catarrhal pneumonia.

2. *Bronchial Form.* The process may extend from the bronchial tubes, a form especially common in children. This extension may be produced in two ways: (*a*) There may be direct inoculation or aspiration, particles being inspired into the smallest bronchioles or air vesicles from the diseased bronchi, and acting like emboli, either *mechanically*, by setting up atelectasis and then pneumonia, or as a direct irritant to the air vesicle, or *specifically* if it contain micro-organisms. In the former case simple catarrhal pneumonia results, and this is probably the commonest form of the disease; in the latter case specific results ensue—suppuration, gangrene, etc. (*b*) Extension from the bronchi may also occur in another way. First, the peribronchial tissues become inflamed, then the intervesicular tissues, and thus, finally, exudation into the air vesicle and catarrhal pneumonia. Catarrhal pneumonia as a result of extension from the bronchi is a common feature in measles, diphtheria and whooping cough, and indeed it is rare to make an autopsy on a case of any one of these diseases without finding patches of catarrhal pneumonia.

3. *Hypostatic Pneumonia* is a form presenting intensification of hypostatic congestion, and very probably due to aspiration. In the agonic period there is a tendency to the settling of irritating materials, due to a paralytic condition of the tubes and failure to be coughed up. The same conditions and resultant pneumonia may be caused by section of the pneumogastric nerve. The pneumonia is not of nervous origin, except that by paralysis of the air passages aspiration is made possible, and we may even find the plugs in the tubes.

Terminations. There is a widespread belief that catarrhal pneumonia is a malignant process, closely related with tuberculosis, and without tendency to recovery. *This is entirely erroneous*, and arises from the fact that catarrhal pneumonia is so often associated with dangerous diseases, in which the conditions for its development are supplied. Thus, in tuberculosis, in diphtheria, measles and whooping cough, catarrhal pneumonia is very apt to appear, and, added to the previous depression of the original disease, often proves fatal. Another source of error is found in the fact that caseous pneumonia is often called catarrhal. *Per se, catarrhal pneumonia is a benign process, more so than croupous, and tends to early fatty degeneration and discharge of the exudate, and resolution.* It is a frequent occurrence in diphtheria and other diseases, and passes off without evil result.

Exceptionally catarrhal pneumonia may terminate in suppuration or gangrene, but as a matter of fact there are cases of suppuration and gangrene in which catarrhal pneumonia is the early stage, being caused by the mechanical action of the irritant materials, after which the specific bacteria cause suppuration or gangrene.

Age. The young and old are especially prone. In children the infectious diseases, with bronchitis, furnish most cases; in the old it may be due to a tendency to hypostasis, paralytic conditions of the bronchial tubes, and chronic bronchitis. There may possibly be some special anatomical reason which we do not know, for not rarely the diplococcus is found to be the irritant, and there must be some special reason for the catarrhal process resulting in children and old people; but what it is we do not know.

Purulent Pneumonia may be of several varieties:

(*a*) The suppurative processes may involve the surfaces of the minute bronchial tubes and air vesicles—a form of *purulent catarrh.*

(*b*) There may be true abscess of the lung.

(*c*) There may be suppurative lymphangitis and perilymphangitis.

Causes. 1. Aspiration of matters containing staphylococci or other organisms of suppuration is the commonest cause, and produces the first or second form of purulent pneumonia, according to the size and nature of the aspirated material.

2. Abscess of the lung may also result from metastasis from foci of suppuration elsewhere along the venous channels. Purulent phlebitis is therefore a common underlying cause, and not infrequently the metastatic lesions in the lung are the first evidences of such disease in the femoral, hemorrhoidal or other veins. In some cases, however, right-sided endocarditis is first developed, then the pulmonary lesion.

3. Traumatism, with or without external wound, may produce abscess of the lung.

4. Suppurative pneumonia is a frequent accompaniment of chronic lung disease, especially tuberculosis. In phthisis the walls of the

cavities are found to be composed of pyogenic membrane, and there is often purulent infiltration of the lung besides. The sputum consists largely of pus corpuscles, and contains more bacteria suppuration than tubercle bacilli.

5. Finally, extension from neighboring suppuration causes certain cases. Thus empyæma may rupture through the lung into the bronchi, and set up abscess of the lung; or abscesses of the liver and other abdominal organs may similarly perforate the lung, and be discharged through the bronchi. A rare form of purulent pneumonia, that characterized by lymphangitis, is an occasional consequence of empyæma, and results from direct extension of the suppurative process along the lymphatic vessels.

Caseous or Desquamative Pneumonia. Next to the tubercle itself, this is the most important lesion of tuberculosis. It is generally an acute process, characterized by exudation of a scanty, tough, albuminous fluid, with decided desquamation of the endothelial cells, and also proliferation of the connective tissue corpuscles of the intervesicular septa.

On section the lung is first found to be generally congested, and presents a somewhat translucent appearance. The exudate in the air vesicles rises a little and produces a somewhat granular surface. Later the involved areas become lighter colored from fatty degeneration and cheesy necrosis, and as all the lobules are never at the same stage, a mottled appearance is produced, some areas being red, others whitish, and still others yellow.

A marked peculiarity of caseous pneumonia is the intense desquamation of endothelial cells early in the case, with proliferation also of the connective tissue of the septa, and even of the walls of the blood-vessels. In consequence of the last there ensues obliteration of the vessels, lack of nutrition, and cheesy change. But the impaired blood supply alone does not account for the caseation, since the obstruction of the circulation is absent in some cases, and since the same processes of cellular infiltration may be produced without tendency to caseous necrosis. There must then be some additional cause, and this is the *tubercle bacillus*, for caseous or desquamative pneumonia is almost always tubercular. This action of the bacilli was well illustrated experimentally by Prudden and others, by injecting *dead tubercle bacilli*, when the same processes of cellular proliferation resulted, but no caseation.

Besides the typical patches of caseous change, with the densely packed cells losing more and more their power to take stains as the cheesy process increases, there are other lobules in which the exudation contains much fibrin. The French have therefore described two forms: (*a*) The desquamative or cellular form, and (*b*) the fibrinous form.

From the distribution of the process we may make three varieties: (1) The *lobular* or ordinary form; (2) a *confluent or lobar* form; (3) a *bronchial* form—" caseous broncho-pneumonia."

On section the outlines of the various areas are easily seen, but sometimes by confluence a lobar involvement presents itself, and gives rise to a peculiar kind of phthisis, with tendency to rapid progress and extensive breaking-down of lung structure. " Galloping-Consumption " or " Phthisis Florida." Usually however, breaking-down is more gradual, involving one lobule after another. In broncho-pneumonia there is particular involvement of the minute bronchial tubes which become filled with desquamated cells. Many investigators think these tubes are the point of origin of the process, but usually they are only involved along with other parts. Finally extensive destruction of the lung results.

Fibrous Pneumonia is the result of cell proliferation and formation of fibrous tissue. This may be an outcome of croupous pneumonia, when the proliferation of connective-tissue cells with formation of new blood-vessels occurs in the septa and extend into fibrin-meshes inside the air vesicles (carnification). So also caseous pneumonia may terminate as fibrous since there is in this form both desquamation of endothelial cells and proliferation of connective-tissue corpuscles which may organize, when caseous change does not occur. Fibrous pneumonia always presents considerable pigmentation.

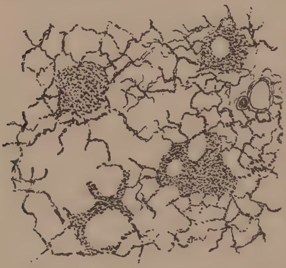
Forms. (*a*) Extension from the pleural and septa separating large groups of lobules. There is characteristic thickening of the pleura from which there extend into the lung rays of connective tissue. Chronic pleurisy frequently produces this form.

(*b*) A parenchymatous form in which the connective tissue proliferation starts from the septa of the air vesicles, as after cases o croupous or caseous pneumonia. More frequently however constan inhalation of dust of various kinds is the cause. There is usuall disseminated induration with pigmentation of the lung, producing "slate-colored" appearance. There are frequently considerabl areas of induration and at times distinct nodules may be felt in th lungs.

(*c*) A peribronchial or more frequently perivascular form als occurs, and presents proliferation of the connectiv etissue about th large blood vessels or bronchi, beginning at the root of the lung an extending outward in a ramifying manner. When such an appea ance is found we think at once of *syphilis*.

(*d*) The repair of any injury to the lung substance is by fibro tissue--hence fibrous pneumonia.

9. Tuberculosis presents three lesions particularly: the tube cle; caseous pneumonia; and fibrous pneumonia. The bacillus tuberculosis is the invariable cause and may reach the lung in thr ways; (*a*) by the blood, (*b*) by the lymph or (*c*) by inspiration.

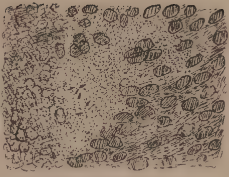

Miliary Tubercles in the Lung.

TUBERCLE

Gray—no degenerative changes.

(*a*) *Hæmatogenous Tuberculosis*, t bacilli carried by the blood, is often wide disseminated, constituting acute miliary tub culosis. The tubercles lie along the bloo vessels and may extend into them, dischar ing their bacilli into the blood and so cau dissemination. The lung of acute milia tuberculosis is intensely congested and pr sents well marked bronchitis, especially the smaller tubes which are filled with mucus and a slight amount blood. The tubercles are small, grayish and translucent bodies, whi may escape observation unless care be taken, for their translucency permits the dark substance beneath to shine through. Oblique light brings them prominently to view as small grains of sand. They are rarely cheesy since the patient dies so early of the general systemic poisoning by the bacillus in the blood. If life is preserved the tubercle grows larger and becomes more apparent—first whitish, then cheesy. Such changes are observed especially in the miliary ubercle in localized forms of tuberculosis.

(*b*) *Extension by the Lymph-paths*, is the ommon method of extension of the process in e lung itself, but the tubercle may be carried the lung in this way, from tubercular disease f the pleura, and sometimes from the mouth nd nose, especially the tonsils. In the latter ases the bacillus is first conveyed to neighboring lymph glands, later to the venous channels to the heart and finally to the lungs, where lodges, for this is the first capillary circulation encountered. This a form of mixed dissemination by the lymph and blood.

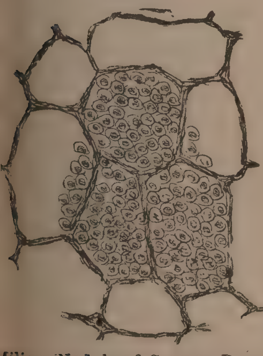

CHEESY TUBERCLE

(*c*) *Inhalation* is the most frequent method of infection of the ngs. Clear evidence is furnished by causing animals to inhale dust ontaining bacilli, or in any case of tuberculosis, clear evidence is seen ithin the lung, Thus a tubercular nodule, not communicating with bronchus, may break into one, when the contents of the mass are for e most part coughed up, but some are always inspired deeper into e lung and are seen to set up further disease.

Why then do we not all develop tuberculosis, since the bacillus so wide-spread and we all breathing it? As in animals some are mmune, others susceptible, so in man a certain susceptibility must be resent to cause the trouble. Disturbances of nutrition of all kinds, revious lung diseases and especially inflammatory conditions of the ronchi, such as notably those in diphtheria, scarlet fever and measles, ch conditions predispose strongly, and the bacilli find a favorable soil.

Seat. In the adult especially the apex; in children other parts lmost as frequently.

Pathological Anatomy. The first manifestation is as minute nodules, in the majority of cases (from inhalation) "miliary nodules of broncho-pneumonia." These, at first isolated and sometimes continuing so, usually run together and form larger masses. At the same time, the process extends along the walls of the air vesicles to neighboring ones, where it sets up caseous pneumonia, and thus, exceptionally almost, a lobar caseous pneumonia may result. Again, there is simultaneous extension along the lymph-paths, and formation of new nodules


iliary Nodule of Caseous Pneumonia.

in the lymphatics of the walls of air vesicles, at some distance from the original focus, with an intervening space of healthy lung. The primary focus presents a more advanced stage than do the nodules along the lymph-paths.

Whatever way the bacillus enters the lung there is tendency to form *miliary tubercles*, and these again, mainly by extension along the lymph-paths, cause *secondary miliary nodules*, and at the same time excite a *caseous pneumonia* in the air vesicles round about. The walls of the air vesicles are at the same time affected, and from all of these factors arises consolidation of the lung, which tends to cheesy change. Consolidation is usually localized, rarely widespread. Though the tendency to destructive changes is usual in the tubercle, occasionally fibrous change occurs, as in horned cattle, and as we noticed in the case of caseous pneumonia. Such fibrous change is found in nearly every case in some part of the lung, but sometimes predominates when we speak of "fibroid phthisis." This is a favorable termination and may occasion entire cure. When cure does occur, it is always in this way. The tendency to fibrous change is sometimes seen about cheesy foci, which become "encapsulated," and thus become slow cases without destructive bearing-down. So, also, in the walls of cavities, in parts where the processes have become slowed, fibrous change becomes apparent.

Complications. 1. Inhalation from previously affected areas causes spread of the tuberculosis. The greater part of broken-down tissue is expectorated, but portions are also inspired into the deeper parts of the lung, there to set up further tuberculosis. Frequently other micro-organisms are present, and being thus inspired, set up other pathological processes according to their specific nature. In this way catarrhal or croupous pneumonia or suppurative processes originate. Croupous pneumonia is exceptional, affects large areas, and may be recognized by physical signs. Catarrhal pnuemonia is frequent, affects patches of lung near the original focus, and is not easily recognized. Suppuration occurs sooner or later in nearly every case. In case of cavities there must necessarily be infection of their walls by inhalation. In other cases small abscesses, or, more frequently, suppurative processes in the bronchi result from such inhalation. In consequence of the suppuration, definite symptoms arise, and we have to deal with a case of "double infection."

Action of the Products of the Bacillus. The effects obtained from

Koch's "lymph" are identical with those every day resulting from auto-infection in cases of tuberculosis. One of the most peculiar of these effects is intense engorgement of the tissues around the focus of disease. This is in a measure a conservative process, since it counteracts the anæmia due to obstruction of the blood-vessels which occurs in the tuberculosis, and which leads to cheesy change. It is a general rule that all morbid processes have within them a tendency to cure themselves, no matter how great their tendency to grow from bad to worse. This is best seen in acute infections, though also in tuberculosis, but here the hyperæmia, while it opposes degenerative tendencies, is a part of increased circulating activities, both in the blood and lymph, and therefore there is greater tendency to dissemination of the disease.

An interesting series of experiments were conducted by Prudden to determine the action of dead tubercle bacilli on the lungs. He found as a result of their injection lesions like those of true tuberculosis: formations of epithelioidal cells and giant cells, round cell infiltration, etc., but these are not characteristic of tuberculosis, since they occur in many conditions. As a result of the action of living tubercle bacilli there is a tendency to obstruction of blood-vessels and to cheesy changes, both of which conditions failed in the case of the dead bacilli. On the contrary, there was a tendency to the formation of new blood-vessels and of new connective tissue. Necessarily the lesions produced by the dead bacilli remain local, since the cause is the mechanical irritation and the action of a living germ.

Advanced Tuberculosis of the Lung is frequently manifested by cavities—single or multiple. These are most marked in the upper lobes, and may occur in series, opening one into another; they usually communicate with bronchial tubes. The walls are soft and dark in color from deposition of blood pigment, and from the pigment of the broken-down tissue, shreds of tissue hang from the walls of the cavity in parts, while in others may be seen ribs of fibrous tissue resembling the columnial carniæ of the heart. Blood-vessels may be seen running through the cavity, or in its walls; they may present miliary aneurisms, and frequently rupture in consequence.

The Bronchial Tubes also take part in the process, and the terminal branchioles may be the starting point of miliary tubercles, or more frequently, of caseous bronchitis from inhalation. Nearly every case shows some areas where the latter may be seen, when the bronchi and the tissues around are involved, small nodules with a central perforation are seen on section through the lung.

Pleural Complications. In nearly all cases of miliary tubercle of the lung there are miliary tubercles in the pleura. In all cases where tubercular foci lie near the pleura, there is involvement of the pleura with formations of adhesions or effusion of liquid. Perforation of cheesy masses under the pleura leads to empyema, pneumo-thorax, or both.

10. Syphilis is rarely demonstrable in the adult, and in many of the cases of syphilis of the lung—clinically so-called—no lesions are demonstrated post-mortem. Very rarely gumma occurs and is distinctive. In some cases in the adult induration is observed—bands of connective tissue passing from the root of the lung outward. In cases where this lesion occurs we always think of syphilis.

Hereditary Syphilis may appear as :

(*a*) Gummy tumors of the same structure as elsewhere, ranging in size from a split pea to that of a lemon. The gumma lies imbedded in new connective tissue, near the root of the lung and generally under the pleura, though it may occur in any part. At first gray and translucent, later degenerative changes render it yellow or cheesy. It is always imbedded in new connective tissue.

(*b*) Syphilitic pneumonia, a condition resembling caseous pneumonia, but without the tendency to undergo degeneration. Cell proliferation occurs in the air vesicles, but more prominently in the intervesicular septa. The latter is the most characteristic appearance. If this process is completed in intra-uterine life the air vesicle walls grow together and cannot be distended after birth. In consequence of this a condition resembling " carnification " results. The healthy parts of the lung are hyperæmic, whereas the diseased portion receiving only the blood requisite for its tissue life and no extra supply for respiratory purposes, is anæmic, and pale—hence the name given the whole process, " white hepatization," " white pneumonia."

11. Glanders may extend along the air tubes to the lungs and sets up nodules of broncho-pneumonia, with tendency to breaking down of the exuded cells and pulmonary tissues.

12. Actinomycosis is much less common, but gives similar appearances. It is a not uncommon disease about the mouth. The parasitic cause is peculiar and distinctive.

13. Tumors are rarely primary. Primary sarcoma is extremely rare. Primary cancer occurs and springs from the bronchial tubes, but only very exceptionally from the lining of the air vesicles.

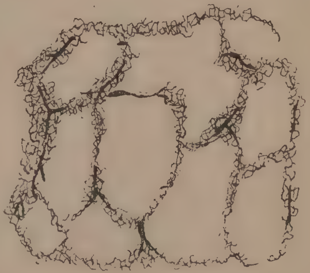
Secondary tumors are not rare. Chondroma, sarcoma, cancer, may be found. Secondary growths may result from extension or by hæmatogenous deposit—metastasis.

14. Emphysema is the general term designating all of those conditions in which the air in the lungs is in excess of the normal proportion compared with the solid tissue structure. Several forms are described:

(*a*) *Acute Dilatation of the Air Vesicles* is simply a stretching of the air vesicles, and, in a measure, an accidental condition. There are two causes: (1) it may be due to transient obstruction to the bronchial tubes, as by a plug of mucus, which allows the air to enter, but not to escape, and thus leads to temporary dilatation of the vesicles; and (2) there may be vicarious dilatation, due to various causes, as for example, dilatation of the air vesicles about atelectatic areas.

(*b*) *Interstitial Emphysema*, a condition in which the air is found in the interstitial connective tissues of the lung structure. This is usually due to rupture of the air vesicles from vigorous respiratory efforts, with obstruction of the tubes. Such may occur in whooping cough. The appearance of the lung is characteristic, for the air soon finds its way to the loose connective tissue under the pleura and appears as blebs, which may be pushed from place to place.

(*c*) *Emphysema* proper, the disease known by this name, or also by that of "Substantial Emphysema," is a chronic process, which may involve all parts of the lung structure, though like all forms certain parts are particularly involved. Thus the upper lobes and the anterior margin are particularly susceptible.



The lung becomes larger, is light in weight, presents rounded edges and collapses readily on section or pressure with the hand. On section a peculiar appearance is presented by the alternate pale hue of the distended lung and the pigmented areas, which become particularly prominent on account of the pale structures around. The air vesicles, which are hardly visible in the normal lung, may become greatly distended and prominent. Under the pleura there are seen minute bubbles, in appearance much resembling the air bubbles on the sides of a glass containing carbonated water. These bubbles cannot be pushed aside, and may grow quite large from the confluence of several smaller ones.

Structural changes begin by dilatation of the air passages, the terminal air tubes leading to the air vesicles; and, following this, atrophy of the septa between the vesicles, this process always beginning at the free margin of the septa. The partition may be completely removed, and in consequence two vesicles run together. The process of removal is one of fatty degeneration.

Ætiology. Two factors are necessary: (1) a predisposition of the tissues to degenerate, and (2) a distending force. There is clear evidence of both in certain cases.

1. Certain persons may have chronic bronchitis, asthma or chronic cough for years, with all the attendant obstruction to breathing, and yet never develop emphysema, while others soon become affected. This predisposition is unquestionably *hereditary* in some cases, but in others is *acquired*. Of other diseases causing predisposition, chronic diseases of the lung and chronic catarrhal pneumonia, or repeated catarrhal pneumonia due to chronic bronchitis, are examples. Some have claimed that there is an anatomical reason, consisting of a lesser amount of elastic tissue in the septa, but this has not been proved. It seems certain that where there has been some chronic obstruction of respiration dating from childhood, such as nasal disease and the like, the disturbance of nutrition from deficient respiration may cause predisposition.

2. As to the distending force, it is evidently expiratory. This is seen in the fact that the upper lobes and anterior margins, parts not protected in the respiratory efforts, are particularly affected.

(*d*) *Atrophic Emphysema*, a condition of old age, is due to a gradual atrophic change in the septa by the same processes as in emphysema proper, but not accompanied by distending force. The lung is smaller instead of larger than normal. We might make a hypothesis that this atrophy of old age is due to the fact that less surface of exposure is necessary, and that, in consequence, the septa, which increase surface, disappear.

THE PLEURA.

The pleura resembles the pericardium, both in its anatomy and pathology, though somewhat different macroscopical appearances are presented sometimes.

MORBID PROCESSES.

1. Passive Congestion is a frequent consequence of valvular heart disease, and leads to serous transudation or *hydrothorax.* There is no inflammation, and the pleura may remain healthy a long time. Eventually, however, it becomes swollen, œdematous and cloudy.

2. Hæmothorax, the accumulation of blood in the pleural sac, is most frequently due to traumatism or rupture of aneurisms into the cavity. The effused blood is rapidly absorbed.

3. Pneumothorax, gases in the pleural cavities, is generally due to rupture of the pulmonary layer of the pleura, such being due to rupture of a tubercular cavity, gangrenous patch, abscess of the lung, or of a subpleural emphysema vesicle. Like hydrothorax or hæmothorax, it causes compression of the pulmonary tissues.

4. Inflammation. Pleurisy. Pleuritis. The same histological appearances as in pericarditis. The exudate is serous, sero-fibrinous or fibrinous. In ordinary acute pleurisy, with tendency to recovery, the exudate is sero-fibrinous. In more chronic cases the exudation is thicker—fibrinous, and tends to aid in formation of adhesions, the two layers of the pleura being first agglutinated by the fibrin, after which proliferation of cells and formation of new blood-vessels bring about complete organization of adhesions. The fibrin itself becomes absorbed.

Occasionally there is decided tendency to suppuration, constituting a condition called *pyothorax* or *empyæma.* In these cases there is usually infection with the organisms of suppuration, but occasionally with organisms not generally associated with suppurative processes, such as the pneumococcus. There is some question whether there are not in these cases some micro-organisms of suppuration which are overlooked. Some authorities contend that the micro-organisms found, though not usually, do sometimes produce suppuration.

Causes of Pleuritis. (*a*) Idiopathic cases, often starting from some local inflammation of the lung, but usually ascribed to obscure conditions or to the action of cold; (*b*) rheumatism; (*c*) Bright's disease; (*d*) extension from neighboring inflammation; (*e*) infectious diseases, when the micro-organisms act as the direct cause; (*f*) tuberculosis, causing mainly chronic pleurisy, with persistent, large exudations.

The suppurative form of pleuritis, empyæma, may result from extension of the suppurative processes from neighboring structures, as from diseased bones, from abscess of the lung, or from distant abscesses, as those of the abdominal cavity, which find their way through the pleura and lung into the bronchial tubes, to be discharged externally. Empyæma may also be produced by septic embolism in general pyæmia.

Results of Pleuritis. Large effusions push the viscera and especially the heart into abnormal positions. After the disappearance of effusion, and particularly in chronic pleurisy, fibrous change may occur in the lung from extension, or bands of adhesion may draw upon the heart or chest wall, producing various disturbances.

5. Tumors. Any neighboring tumor may involve the pleura by extension. *Endothelioma* is a form of sarcoma found in the pleura and other serous membranes.

THE THYROID GLAND.

This glandular organ, situated at the origin of the trachea, consists of two lateral lobes united by an isthmus which passes in front of the trachea. Its weight is from 30 to 60 grams.

Histologically, the thyroid is composed of closed follicles lined with cuboidal epithelium, with considerable connective tissue and blood-vessels between the follicles. It is the normal tendency of this epithelium, which lines and often fills the follicles, to undergo colloid degeneration.

Function. Much study has been devoted to this gland, especially of late, but the function is still uncertain. (*a*) According to an old view, the thyroid is a diverticulum for the circulation going to the brain. (*b*) More recently it has been claimed that the thyroid manufactures substances which (1) have some direct action in the system, or (2) destroy poisonous materials, which, if not removed, cause the condition seen or extirpation of the gland—viz., *cachexia strumipriva*, or myxœdema.

Myxœdema is produced not alone as a result of removal of the thyroid, but also in consequence of disease of this gland.

Symptoms. There are serious disturbances of the nervous system, such as slowing of the muscular, volitional and all mental functions, and tendency to paresis. There is also the peculiar change in the areolar tissue, which has suggested the name myxœdema. The swelling of the areolar tissue affects the face and hands particularly. It was formerly thought to consist of mucin, wholly or largely, but it now appears that this is not a necessary factor. It is readily distinguished from œdema by being harder and in not pitting on pressure. There is a certain amount of inflammatory change in the process, as evidenced by the cellular proliferation visible microscopically.

Malformations. *Accessory thyroid glands* occasionally occur in numerous localities, especially behind the trachea, between it and the œsophagus, or even inside the trachea. They are of interest as explaining why, in some experiments, removal of the thyroid in monkeys did not cause myxœdema. In some of such cases accessory glands were afterwards discovered. Occasionally the supernumerary thyroids may hypertrophy to compensate disease or deficiency of other parts.

MORBID PROCESSES IN THE THYROID GLANDS.

1. Circulatory Disturbances. *Grave's Disease* has for its essential feature, so far as the thyroid is concerned, enormous dilatation of all the blood-vessels, the arteries, capillaries and veins. In consequence of this pulsation is a marked symptom. The cause of this disease is obscure, and though it is now commonly regarded as some disturbance of the nervous system, this is not by any means clearly proved.

2. Inflammation, a form of acute parenchymatous inflammation, resembling mumps, with sudden onset, severe manifestations, acute course and tending to resolution, sometimes occurs, but is rare. Exposure to cold acts as the starting point of this process, Suppuration, abscess, is an exceptional termination of acute thyroiditis. There may also be termination in chronic enlargement—goitre—especially in localities where the latter abounds.

3. Chronic Enlargement or Goitre is a condition whose nature is obscure and not yet determined. It is hard to decide whether these enlargements are simple hypertrophy, or whether they are adenoma. The normal structure of the thyroid is exactly that of adenoma, therefore hypertrophy of the gland would present a similar appearance, and it is perhaps impossible to decide which of the two goitre is.

Macroscopically, however, we could say that uniform enlargements are hypertrophy, whereas circumscribed nodular outgrowths would indicate adenoma. In any case, the constant sprouting of the follicles with formation of new ones is typically adenomatous. There is never any marked deviation from the normal structure of the gland.

One of the marked features of the epithelium of the follicles is to undergo colloid degeneration, and thus to contribute to the great size of the gland. In some cases the colloid material accumulates and becomes more fluid, forming cysts and constituting the condition called "cystic goitre." The colloid nature, however, is characteristic.

Again, there is tendency to hyperplasia of the connective tissue between the follicles, and fibrous change in consequence.

Sometimes there may be hemorrhage into the follicles or the connective tissue, with subsequent absorption of the blood (coloring matter, etc.) and formation of cysts. The hemorrhages, too, may be the irritant that provokes the fibrous change.

Teleangiectatic blood-vessels also occur.

Finally, calcareous infiltration is a common condition in goitre, whether other degenerative changes have preceded it or not.

Generally these different pathological conditions coexist in the same case of goitre, causing a very varied appearance of the gland.

Ætiology. Nothing is known definitely, though certain regions are known to predispose. Much has been said about the water that is drunk in these places, but there is good reason to suspect infectious agency, for the disease occurs epidemically in the regions indicated, is hereditary, and often some evidence of its presence is seen in the gland at birth.

When there are no marked changes in the thyroid there may be at birth evidence of previous abolition of the function of the gland in the deformed, dwarfish bodies of these *cretinoid* children. The subcutaneous tissue is myxœdematous, and there is some disturbance at the line of growth of the bones, with resultant dwarfish condition.

CHAPTER VIII.

THE MOUTH.

Malformations. Most of these belong to the class represented by hare-lip, and are due to failure of the branchial arches to unite. It

Palital plate

is to be remembered that the lower part of the face is formed by the union of four branchial arches. When these fail to unite, fissures result. Thus there may be fissure of the lip, "hare-lip"; of the alveolar process of the maxillæ; of the hard or soft palate, "cleft-palate." The partition is rarely in the median line in front.

MORBID PROCESSES IN THE MOUTH.

1. Inflammation of the Mucous Membrane. Stomatitis.

(*a*) *Simple Catarrhal*, such as is produced by irritants.

(*b*) *Aphthous Stomatitis Aphthæ*. A localized form with tendency to the formation of minute patches of coagulation necrosis. It first appears as minute vesicles, which later become whitish from coagulation necrosis, and then undergo fatty degeneration.

in cattle is of this type. Is epidemic. Affects man as well but milder.

(*c*) *Pustular* sometimes occurs in smallpox and other conditions.

(*d*) *Follicular* affects the mucous glands, which become filled with material and infected with micro-organisms, so that follicular abscesses result.

(*e*) *Suppurative*, of more extensive distribution, occurs especially about the gums as a result of dental diseases.

(*f*) *Ulcerative Stomatitis* generally begins about the root of the incisors, especially of the lower jaw, and tends to produce deep-seated trouble in the alveolar cavity, or even in the bone itself—a superficial necrosis. This form may be due to poisons, like mercury, or to various other causes.

Gangrenous Stomatitis, affects principally the cheek. Probably due to the streptococcus.

All of these inflammatory conditions of the mouth are generally due to impoverished general nutrition.

2. Infectious Diseases.

(*a*) *Syphilis*. The mouth is a frequent seat of the mucous patch, especially about the lips, cheeks and tongue. The hard chancre occasionally occurs; the gumma very rarely in the anterior part of the mouth, so that syphilis does not often cause destructive changes in this region.

(*b*) *Tuberculosis* may appear as the tubercle or as an ulcer, but these lesions also are rare in the anterior part of the mouth. *Lupus*, beginning on the nose or upper lip, may extend into the mouth and cause serious destruction.

(*c*) *Actinomycosis* is quite rare, but affects the bones of the upper and lower jaws.

(*d*) *Thrush* occurs about the cheeks, gums, etc., and may extend back to the fauces, œsophagus, and even the stomach, though rarely. A fungus of the oidium group is the specific cause. It may be found between the epithelial cells and within them. It is difficult to classify this fungus, but it may be considered a transitional form between the yeasts and the moulds—the highest form of yeasts and the lowest of the moulds. It consists of a mycelium and hyphæ, and, instead of special organs of fructification, has on the hyphæ conidia, which sprout like the yeasts. There are other fungi of this group of Oidia which cause disease, such as those of favus, of barber's itch, and of pityriasis, but the one in thrush most closely resembles the yeasts. The disease presents a white covering on the mucous membrane, at first resembling diphtheria. This is surrounded by a zone of inflammation. Diminished alkalinity of the secretions of the mouth is the predisposing cause.

(*e*) *Cancrum Oris. Noma.* This is simply gangrene of the cheek. There is no clear evidence of a specific cause, but the micro-organisms of suppuration are found in considerable numbers, and as necrosis proceeds, saprophytic bacteria also. The disease occurs in children of broken-down health. Disturbance of circulation causes coagulation necrosis of the cheek; this area becomes infected with micro-organisms, and more rapid necrosis ensues—a true gangrene. By extension the whole side of the face and even the bone may be involved. Noma occurs, especially, in overcrowded hospitals, asylums, etc.

3. Tumors.

(*a*) *Lymphangioma* of the tongue and lip (macroglossia and macrocheilia) occur early in life, and may be congenital. The parts affected grow large, sometimes becoming enormous.

(*b*) *Sarcoma* is generally in close connection with the mucous membranes about the bones, especially the gums. Such tumors, called *epulis*, spring from the alveolar processes, and are generally giant-celled sarcomata.

(*c*) *Flat-Celled Carcinoma or Epithelioma* is most frequent on the lower lip, beginning midway between the middle line and the angle of the mouth. It begins as a papule which has a tendency to ulcerate, but it is of slow growth. This tumor supports the mechanical theory, in that irritation is frequently the localizing cause, no matter what more important predisposing cause existed before. These cancers of the lip are commonly produced by the irritation of the pipe-stem used by smokers. Most common form and affects males principal

SALIVARY GLANDS.

1. Parotitis. Acute Inflammation of the Parotid. Mumps. A true inflammatory process, with all the histological characters of such, and not, as is often urged, a condition of congestion or the like. Mumps is a form of infection, eminently contagious and often epidemic. The organism, as yet undetermined, probably finds its way up the duct of the parotid from the mouth, since we know that certain other micro-organisms, as those of suppuration, gain access in this way. The termination is usually in resolution, rarely suppuration. The latter is caused by entrance of micro-organisms of suppuration in the way stated. Occasionally there is little tendency to resolution, the exudate remaining in the gland and presenting some tendency to fibroid change. Such an occurrence is rare.

2. Suppuration of the Salivary Glands is not a rare condition in connection with certain infectious diseases, like diphtheria or scarlet fever, which cause inflammations of the mouth and the throat.

3. Retention Cysts are developed especially in connection with certain sublingual mucous glands. A considerable swelling, generally called *ranula*, results. In the great majority of cases the contents of such are fluid, but after a long time calcification may occur.

4. Tumors. The majority of the tumors of the parotid are of the kind called "mixed tumors." These are generally composed of myxoma, chondroma and sarcoma, and are called *myxo-chondro-sarcoma*. Very often there is a certain amount of fibroma as well.

The form of *carcinoma* found is that called "tubular epithelioma." The epithelial cells in this are irregular in shape—many being cuboidal, and of the appearance of those seen in glandular cancers, but some typically squamous cells may also be found in "pearly-bodies." The epithelial plugs extend in different directions as long, ramifying, finger-like projections.

Most tumors above the neck is squamous

FAUCES. PHARYNX. TONSILS.

1. Inflammations of the throat may be due to some well-known irritant, or to the indefinite causes of inflammation of mucous mem-

The parotid is a seat of mixed tumors

Mercurial Stomatitis is due to micro organismal inflammation and can be treated antiseptically

branes, generally classified as "cold." *Simple catarrh* of the fauces presents the appearance of all catarrhal inflammations. In other cases there is added to the general catarrhal inflammation, *follicular inflammation;* in still other cases, liquefaction necrosis with formation of vesicles occurs, and the vesicles may rupture, leaving minute, superficial erosions. This is true *herpes* of the throat, comparable to *herpes labialis, preputialis, etc.* In smallpox we may also find *pustules* in the mucous membrane.

May be mistaken for Diphtheria.

2. Tonsilitis may be catarrhal, in conjunction with inflammation in the throat, or in other cases it may be confined to the *crypts* or *lacunæ*, small follicles in the tonsil lined with epithelium. This is called *lacunar tonsilitis.* Its peculiarities are due to the anatomical arrangement of the parts, the catarrhal elements accumulating within the follicles, undergoing fatty degeneration, then decomposition and being discharged as fœtid plugs, or remaining and becoming calcified. Such is the description of a subacute case. In an acute the contents of the lacunæ are discharged, and collect on the surface as a membrane resembling the diphtheritic, but differing in being softer and in being readily removable. When it is stripped off, the crypts with their creamy contents are readily seen, especially after effort like coughing, or after pressure on the tonsil. When the contents of the crypt are retained suppuration may result—not so frequently, however, as we might expect from the number and variety of bacteria contained in the collections in the crypt. The suppuration may be confined to the lacunæ or extend as a large abscess of the tonsil, which usually ruptures into the throat and heals, but may kill by suffocation or erosion into a blood-vessel, causing hemorrhage.

Quinzy is a form of tonsilitis

3. Abscess of the Tonsil may, however, occur without previously existing tonsilitis. This condition, called *quinsy*, may result from repeated attacks of tonsilitis, such as occur habitually in some persons; or the origin may be entirely obscure. There must, of course, be inoculation with micro-organisms in some way.

4. Diphtheria often begins in this region and extends to other parts. An anærobic bacillus. Twice as thick as tubercle bacillus. Has no motion of its own. Grows on all medium [illegible] in labs

5. Chronic Inflammations may be of two forms: (*a*) affecting the mucous gland—"glandular chronic inflammation," or (*b*) involving the lymphatic tissue, or "granular chronic inflammation." The two forms are similar clinically, but anatomically there is the difference stated. In both forms there is considerable swelling, especially

White of egg hard boiled is the best culture medium for bacillus of diphtheria, cut in small cubes and place in bottom of a test tube in which a small amount of water is placed. Keep at a temperature of 38° C. We do not require a microscope. Colony is sufficient will show in 24 hrs

streptococcus may fool us but this will not grow
on white of egg so soon.

marked about the mouth of the glands in the first form, or in the lymphatic tissue in the second. Later there is atrophy, and the mucous membrane becomes smooth, with large, conspicuous blood-vessels.

Chronic Inflammation of the Tonsils causes hyperplasia of the lymphoid elements, and constitutes the "enlarged tonsils" recognized clinically. Abscess frequently occurs, as also lacunar inflammation.

6. Infectious Diseases.

(*a*) *Syphilis* is the most frequent infectious disease of the mucous membrane of the throat, outside of diphtheria and suppuration. This is a favorite seat for the secondary lesions, also for the gummy tumor which is found especially in the mucous membrane of the soft and hard palate. The latter may cause extensive ulceration and perforation of the soft or even the hard palate, or it may extend along the pillars of the fauces to the tongue, epiglottis and larynx. The remnants of such lesions may be the only remains of past syphilis. Scars of the soft palate are quite characteristic, though of course they might be due to other causes, as injury, etc. Occasionally (*b*) *tuberculosis* also occurs on the soft palate, but is rarer than syphilis, or, perhaps more correctly, rarely assumes serious tendencies in this locality. It is probably more common than we think, and since the discovery of the tubercle bacillus tubercular lesions have been more frequently detected. The appearances are those of tuberculosis elsewhere.

THE ŒSOPHAGUS.

1. Inflammation is most frequently due to the action of irritants.

2. Diverticula, or pouches of the œsophagus, occur in different portions of the tube and from different causes: (*a*) Lateral pouches are really congenital malformations, due to failure of the branchial arches to unite properly. (*b*) Diverticula of the posterior wall occur especially in the upper portion of the œsophagus, opposite or just below the cricoid cartilage. The pouch portrudes between the fibers of the inferior pharyngeus, and may hang down some distance. Such are due to injury, as the passage of foreign bodies which cause ulceration, and thus weakening of the walls. Subsequently pouching occurs by pressure from within. Various materials may collect in these sacs, undergo decomposition, and frequently abscess results. (*c*) Anterior diverticula are most frequently brought about by disease of the lymph-glands in front of the œsophagus. As a result of various inflammatory processes, perhaps abscess, dense connective tissue adhesions are formed between the anterior wall of the œsophagus and the remnants of the diseased lymph-glands. These adhesions subsequently contract and produce funnel-like diverticula. The shape is evidence of the mode of formation. These are most frequent opposite the tracheal bifurcation.

3. Stricture may occur in two localities particularly: opposite the cricoid cartilage and opposite the tracheal bifurcation, points before seen to be common seats of diverticula. These points are especially exposed to the action of irritants, as the tube is less dilatable here than elsewhere. At the cricoid there is distinct bulging into the œsophagus, and at the bifurcation the same, from the fact that one of the cartilaginous rings is complete behind.

Causes. (*a*) Pressure from outside, as by tumor or aneurism. This may be situated at any point. (*b*) Cicatricial contraction of the tube, most frequently due to ingestion of irritant poisons, hot water, etc. Ulceration occurs; then cicatrization. (*c*) Cancer, the flat-celled epithelioma usually; tends to form at the two points of greatest irritation.

The œsophagus above the stricture undergoes dilatation, with papillomatous condition of the mucous membrane in some areas, and atrophy from dilatation in others.

THE STOMACH.

The stomach is a very movable organ, the greater part of which lies in the left hypochondriac region. The cardiac or œsophageal end is the most fixed portion, and lies opposite and a little to the left of the twelfth dorsal vertebra. From this point the stomach outline may be traced to the left and downward around the fundus, then toward the right, where it terminates in the duodenum.

Anatomy. The stomach is covered by the peritoneum, which constitutes the *serous coat.* This completely covers the organ, except a line along the great curvature where the posterior peritoneal covering meets the anterior. The next or *muscular coat* is composed of longitudinal, circular and oblique fibers in the order named, from without inward. The last are continuations of the circular fibers of the œsophagus. The *submucous* and *mucous coats* are internal, and unlike the others layers, not elastic. As a result, contraction of the walls causes ridges in the mucosa and submucosa, these being most prominent in the longitudinal direction, less so transversely. The numerous glands of the mucosa are of great importance. There are two kinds: the *cardiac* and the *pyloric*. The cardiac glands consist of a short neck which at once splits up into several tubes below; the pyloric glands have a longer neck, and at the bottom break up into a few pouches, usually two or three, but sometimes more. The epithelium of the stomach is cylindrical, and the same may be seen in the outlet tubes or necks of the glands. In the gland pouches the epithelium becomes cuboidal, but in the cardiac glands there is an additional cell, much larger than the lining cells or "main" cells, and which lies between these and the basement membrane. These are called the "parietal cells." Small amt. of acid towards the

Functions. The action of the stomach is controlled by numerous nerves, with ganglia situated both at a distance and in the walls of the organ itself. The function of the stomach is to convert albumins into peptone, this process being accomplished by a hydrolytic ferment, pepsin, acting in the presence of an acid—hydrochloric acid. Pepsin is produced by the "main cells" of the glands throughout the stomach, though especially near the fundus; the hydrochloric acid by the parietal cells, and therefore in the cardiac glands, and near the fundus.

It is especially in the stomach that the question of morbid physiology attains great importance, for this organ presents the most marked disturbances of function without structural lesions to explain them; and, on the other hand, the most extensive structural lesions without corresponding functional disturbance.

By very slight deviation from the normal processes of digestion, not peptone, but certain highly poisonous products are elaborated in the stomach, and may be absorbed with production of serious symptoms. These processes of improper elaboration of albumins are also hydrolytic, and bear a strong resemblance to the chemical changes caused by micro-organisms.

Pepsin is an efficient agent in preventing putrefactive processes, and its withdrawal or any alteration of its nature may permit such processes to occur, and thus poisonous materials may be produced.

MORBID PROCESSES IN THE STOMACH.

1. Post-Mortem Changes.

(*a*) *Hypostatic Congestion* may appear early and become quite marked. It is seen on the posterior wall of the stomach, if the body lie on the back, and on examination with a magnifying glass presents distended blood-vessels. It must be distinguished from acute inflammation, which is generally most marked toward the pylorus, by the locality, and by the absence of signs of active inflammation.

(*b*) *Post-Mortem Softening* is a digestion of the stomach walls by the gastric juice. It commences very soon after death, perhaps one or two hours, and also affects the posterior walls when the body lies on the back. The changes are sharply circumscribed to the portions covered by the fluids in the stomach, and beyond this area the walls remain healthy. The mucous membrane first becomes of a cloudy appearance, but we usually see it as a softened and slimy surface. It may become eroded, leaving only the deeper layers, or in some cases the process may extend until complete perforation of the stomach results. Two varieties of softening have been described: (1) white, and (2) brown or red. The latter occurs when there is considerable blood present, as from hyperæmia. Occasionally streaks of brown softening may indicate the direction of the blood-vessels, blood having escaped by diapedesis along the vessels. The pigmentation of brown softening is due to altered hæmoglobin.

(*c*) *Putrefactive Changes* in the stomach must not be confounded with post-mortem softening. Putrefaction may also occur early. It presents a greenish discoloration, with emphysema of the walls.

2. Circulatory Disturbances.

(*a*) *Congestion* may result from irritation, such as alcohol, and if repeated may give rise to chronic inflammation. Usually there is no evident alteration visible at the post-mortem; but if such be present, it is found especially toward the pylorus, and on the crests of the *rugæ* or folds of mucous membrane. In active congestion there is a bright red color; in passive, permanent pigmentation, for this form is apt to be chronic, and due to such causes as obstruction to the circulation in the liver, or from heart disease. Both active and passive congestion may cause petechiæ, more marked toward the pylorus and on the rugæ; and if the congestion be intense, even hemorrhages may result.

(*b*) *Hemorrhage* from the stomach is called hæmatemesis. It may be due to (1) rupture of an aneurism; (2) changes in the walls of the blood-vessels, such as occurs in the ulceration of gastric ulcer or cancer, and which affects branches of the gastro-duodenal artery;

or (3) changes in the blood or blood-vessels in certain acute diseases, like yellow fever, scarletina, diphtheria, smallpox, scurvy, purpura, etc.

The vomited blood is bright red and coagulable when a sudden large hemorrhage occurs; but dark red, altered by digestion, and of the appearance designated as "coffee-grounds" when the hemorrhage was gradual. The "black-vomit" of yellow fever presents the latter appearance.

3. Inflammation.

(*a*) *Acute Catarrhal Gastritis* is frequently a symptom of acute infectious diseases, but may be produced by irritants from without or elaborated in the stomach itself. Such are the poisons produced by decomposition in the stomach contents.

The mucous membrane is swollen and red, usually uniformly, but in other cases especially on the rugæ; and there is some mucus on the surface. Best guide is M. M. of œsophagus.

Microscopically, the blood-vessels are seen to be congested. There is cloudy swelling of the cells, some shedding of the epithelium, and slight round-celled infiltration between the tubules.

(*b*) *Diphtheritic Inflammation* may be truly diphtheritic, or may be a process of coagulation necrosis due to irritant poisons or infectious diseases, such as scarlet fever, smallpox, septic infection of the umbilicus of the new-born. These causes produce coagulation necrosis of the mucosa, not to be mistaken for true diphtheria. Mineral acids nearly always cause coagulation necrosis in certain points, as also erosions and hemorrhage.

The areas of coagulation necrosis are subsequently removed by a process of ulceration such as occurs elsewhere, with exudation of round cells and formation of granulation tissue.

(*c*) *Suppurative Conditions.* Abscesses may occur in the submucosa and appear as circumscribed swellings, which often rupture into the stomach by a number of small openings. The condition is called "gastritis phlegmonosa."

One form of abscess, called "idiopathic abscess," is of doubtful ætiology, though we know that many such occur in drunkards. Other cases are more clearly understood. Thus in general pyæmia emboli may lodge in the stomach and cause abscess. Again, suppuration may extend from neighboring structures, as the liver or spleen, and in the vicinity of tumors of the stomach there is usually some suppuration. Lastly we occasionally see "pustular" or

Productive Inflammation or Prod. Chron. Gastritis may give rise to marked swelling of some portions of M. The normal rugae can be made to disappear but there can not on distention of stomach, a distention of the glands themselves. And cysts may form in them. And gland filled with mucous.

"follicular" suppuration in the stomach, such being found in small-pox and in poisoning by tartar-emetic, especially if the drug is introduced by other channels than the stomach.

3-21-189[illegible] (*d*) *Chronic Catarrhal Affections* are characterized anatomically by *thickening* and *pigmentation*—therefore productive inflammation. In acute catarrhal conditions there are a few round cells between the glands; but in the chronic, cell proliferation and infiltration between the glands are characteristic. Chronic or repeated congestion is the common cause and leads to pigmentation, which is especially marked toward the pyloric end. If there be an acute exacerbation of inflammation the color is bright red, but when only the chronic congestion is present the color is dark purplish or bluish, and distended veins may be visible. To superficial examination the color is uniform, but on examination with a magnifying glass minute points of pigmentation are brought out.

Microscopically, cellular infiltration is marked, especially toward the surface of the mucous membrane. This causes thickening and enlargement of the gastric tubules, so that they are distended in some parts and distorted in others. This change of the tubules with cellular infiltration about them leads to a great increase of the normal granular appearance of the mucous membrane—whence the name "gastritis granulosa." When cell proliferation is still more marked there may be actual projections on the surface, causing "gastritis polyposa." In severe cases true polyps are formed; and, from obstruction of the glands, small cysts, visible to the naked eye. These various hypertrophic conditions finally lead to atrophic, from the appearance of cicatricial tissue. The proliferated cells between the glands lie for a long time unorganized, but finally form connective tissue, which contracts and leads to scars and atrophy.

Causes. Most cases are due to the continued action of some irritant, as alcohol, and next to this chronic passive congestion, such as that due to portal obstruction or the general circulatory disturbance of heart disease, brings on these chronic catarrhal conditions. In both cases a diffuse catarrh, more marked, however, near the pylorus, results. Circumscribed changes often occur about ulcers or cancer, producing polypoid excrescences. About cancers particularly may be seen areas of thickening, which affects the submucosa particularly, and to an extent also the mucous membrane. The glandular substance at the same time undergoes fatty degeneration and atrophy.

4. Infectious Diseases. An acute catarrhal gastritis may occur in connection with all the acute infectious diseases; but besides these there may be manifestations of chronic infections, like tuberculosis or syphilis. In cholera and Yellow fever.

(*a*) *Tuberculosis.* The lesions have been found in some cases, but not frequently, and we suspect the disease may be more common than is now believed. There may be found cheesy nodules, preceded and accompanied by miliary tubercles, and leading to ulcers. Such ulcers are more frequently seen toward the pyloric end, and present much the same appearance as ordinary ulcers, except that they present in addition miliary tubercles about the edges and floor.

(*b*) *Syphilis* is very rare.

5. Tumors. All except cancer are very rare, and as a rule present no serious symptoms.

Carcinoma. The stomach is one of the frequent seats of primary cancer. The pyloric end is especially both schirrous and medullary apt to be involved, then the posterior wall and the lesser curvative, and last of all the cardiac end. Destructive adenoma, or *adenoma destruens*, is as malignant as carcinoma, though there is seen, under the microscope, a tendency to limit the growth by basement membrane. But the follicles or nests go on multiplying, and break the limiting membrane, proliferating outside and thus becoming cancerous. Destructive adenoma is most frequent about the pylorus, and may be distinguished from other cancers by the frequency of polypoid excrescences.

Medullary Cancer presents itself as fungoid masses, with tendency to ulceration at the center. It has marked tendency to metastasis through the circulation, involving the liver especially.

Scirrhus also occurs, and tends to ulcerate.

Colloid Cancer may appear as nodules, or may be diffuse, presenting a uniform infiltration of the stomach walls over large areas or entirely. It tends to spread by continuity or contiguity, along the stomach or to the peritoneum and along this. Colloid cancers are either cylindrical-celled or glandular cancers which have undergone mucoid degeneration.

Squamous Cancer or Epithelioma is not found in the parts affected by the other forms, but is the most frequent kind at the cardiac orifice.

6. Degenerative Processes are frequent in the gastric mucous membrane, affecting particularly the glandular structure, and may be produced by various marasmic conditions. The mucous membrane

Cancers of stomach tends to ulcerate and may tend to hemorrhage

He thinks the fatty degeneration is secondary.

loses its translucency and rose-gray color, and tends to become opaque and yellow. The same condition may be due to anæmia, coming on acutely in the anæmia of profuse uterine or other hemorrhage, or from similar causes, or more slowly in the various malignant anæmias, as leucæmia and progressive pernicious anæmia. In the latter fatty degeneration of the mucous membrane becomes prominent, and the question whether this is altogether the result of the anæmia, or partly the cause, is raised. The matter is, however, still unsettled. Similar fatty degeneration may also follow slow poisoning by arsenic or phosphorus, without production of irritation.

7. Gastric Ulcer. Peptic Ulcer. Round Ulcer. The stomach wall has a natural resistance to the action of the gastric juice, which prevents its destruction; but when, as a result of disease, the vitality of the mucous membrane becomes impaired, fatty degeneration ensues, and finally ulceration.

Seat. Ulcer is most frequent about the lesser curvature near the pylorus, also on the posterior wall.

There may be one or several, ranging in size from a pin's head to the palm of the hand. They present different appearances according to the depth to which ulceration has extended. The *shape* is often funnel-shaped, with the apex toward the serous membrane, because the mucous coat has been first and longest affected; but very frequently, perhaps in the greater number of cases, the bottom of the ulcer is larger than the opening, and, in consequence, the edges are undermined. This is frequently seen when the serous coat of the stomach beneath the ulcer becomes bound to neighboring organs by adhesions. The outline of the ulcer is round, and the edges smooth, in the typical funnel shape, but in other cases there may be marked hyperplasia about the borders, causing an irregular, elevated and puckered appearance. The floor of the ulcer may present the normal appearances of the different coats of the stomach, or there may be well-defined granulations. Not rarely large blood-vessels traverse the ulcer, but in other cases the walls of the vessels do not resist the ulcerative process, and serious, perhaps fatal, hemorrhages result. Recurring hemorrhages are more common than a large and fatal one. Perforation is not a rare accident from deep extension of the ulcer. The perforation may lead into the intestines, when the results are not so disastrous as when rupture occurs into solid viscera after adhesion to them. Abscesses of the liver or spleen may be produced in this way.

An ulcer may become healed by *organization*, just as occurs elsewhere. There is formation of new connective tissue, but also new epithelium and new glandular tissue. A small ulcer may in this way become wholly regenerated, leaving no trace; but large ones lead to the formation of much connective tissue and the occurrence of scars in stomach. These are characterized by a peculiar radiating character of the connective tissue, all springing from a common center. If very extensive, distortions of the stomach, such as an hour-glass contraction, may occur.

Causes. What brings about the lowered vitality of the mucous membrane which permits of its digestion and formation of ulcers? There are many causes, and it is difficult often to determine which is operative in a given case.

1. Petechial hemorrhages in the mucous membrane cause infiltration of the glandular structure with blood, lowered vitality and ulceration. These ulcers are usually of the nature of superficial erosions.

2. Infarct causes deep ulcers of funnel shape from the ramification of the vessels. The stoppage of the circulation may be embolic or thrombotic, with digestion and ulceration of the obstructed area. But the matter is not so clear as it seems, for not all conical ulcers, perhaps not even a majority of them, are due to embolic stoppage of the circulation, since in some cases no emboli may be found plugging the vessels, and since the stomach does not contain terminal vessels. Still, there must be some circulatory disturbance in every case, though it is doubtful whether hemorrhagic infarction or coagulation necrosis would occur if everything else were normal in the stomach wall.

3. Sclerosis of the blood-vessels, leading to obstruction, is a frequent cause. Here there are several blood-vessels obstructed at the same time. Chronic

4. Venous stasis, as in cirrhosis of the liver or heart diseases, also causes ulceration.

5. A theory has been advanced that persisting spasm of the muscular fibers of the stomach leads to obstruction of the circulation and ulceration. This is more than doubtful.

6. Inflammatory disturbances of nutrition, caused by irritating substances or solids, may so lower the vitality of the walls that they readily yield to digestive processes.

Ordinarily degenerating parts in the stomach are soon replaced by regeneration, and therefore when ulcers do occur it is probably

Bacteria and infectious diseases may be also the cause.

because the normal processes of regeneration are wanting. This may be due to the character of the gastric juice, for this cannot, if normal, digest the mucous membrane *against* the processes of regeneration. It has been claimed that hyperacidity of the peptic juice is the cause of the changes.

Ulcer occurs in adults, rarely in children, and more frequently in women than men.

8. Functional Gastric Disorders without gross anatomical lesions are generally known by the name *dyspepsia*. The symptoms of this disorder may be produced in two ways: (1) by reflex action or (2) by absorption of poisons in the stomach. An irritated mucous membrane becomes very sensitive and gives rise to serious reflex symptoms. Any tissue of the body normally insensitive may become hypersensitive when irritated, as is frequently seen in the retina.

Results of Dyspeptic Conditions.

(*a*) Paralytic relaxation of the pylorus sometimes occurs. It allows the contents of the stomach to pass through the stomach quickly. (*b*) Closure of the pylorus may occur in other cases, and leads to distension from obstruction. Distension may be favored or caused also by paralysis of the stomach coats. The stomach contents are retained a long time and putrefaction occurs, causing local irritation (gastric catarrh), thus a structural lesion following a functional disorder. Again, poisonous products may be produced and cause serious symptoms. In other cases the catarrh comes first, then the functional disturbance and all the other changes. The production of poisons is probably due to micro-organismal growth in most cases. Certain forms of fermentation are very common under these conditions, as the butylic due to a species of bacillus, or lactic, also due to specific micro-organisms.

THE INTESTINES.

The mucous membrane of the intestines is lined with columnar epithelium. It is raised in small projections, *the villi*, also covered with the same epithelial cells, and dips down into the small tubular glands—the *Glands of Lieberkuhn*. Besides these elements, the mucous membrane and submucosa contain much lymphoid tissue, collected in small masses—the *solitary glands*, or in larger groups—the *agminated glands* or *Peyer's patches*.

Function. Certain digestive processes are carried on or completed in the intestines. There are several ferments: a diastasic ferment; a peptone-producing ferment, such as occurs also in the stomach; a ferment which decomposes fat; a milk-curdling ferment; and an emulsifying agent.

Malformations and **Malpositions.** There are many rare abnormalities which are unimportant. An important malposition is—

Hernia, a malposition of any of the viscera, with a tendency to push outside the serous sac which surrounds it. The most frequent form of hernia is the intestinal, the parietal peritoneum being protruded.

Varieties. Internal, in which the protruded gut does not come to the surface; external, in which the integument is pushed out.

Of the external herniæ the most frequent form is the *inguinal*, in which the hernia follows some part of the inguinal canal. It may be congenital, when parts of intestine follow the testicle in its descent to the scrotum, and in this case both the hernia and the scrotum occupy the same sac. There are two kinds of inguinal hernia: the *direct*, in which the protrusion is through the abdominal walls inside the deep epigastric artery; and the *indirect*, in which the hernia follows the course of the inguinal canal and leaves the abdominal cavity external to the deep epigastric artery. *Femoral hernia* is next in frequency to inguinal, and follows the course of the femoral vessels. *Umbilical hernia* may be congenital or acquired.

Of internal hernias an important form is the *diaphragmatic*, in which the intestines are protruded into the thoracic cavity. In another form displacement is backward through the peritoneum into the retroperitoneal space, the horizontal part of the duodenum, the sigmoid flexure or the ascending colon being the part involved. These forms are rare.

Causes of Hernia. In acquired hernia there must be some protruding force, such as strain, heavy lifting, etc. This is the exciting cause. There must also be some predisposition, some diminished resistance of the abdominal walls, either congenital error of development, or an acquired weakness such as comes on with age or the deposit of fat in the abdominal walls. In many cases there is congenitally lengthened mesentery, not to be confounded with the lengthening produced by a long-standing hernia as a result of traction.

The *contents* of the hernia may be the gut alone, or with omentum, or the latter alone. The lower part of the ileum is the most frequent part of the gut protruded on both sides. On the left side the sigmoid flexure may also descend. The omentum alone may escape, or if with the bowel the latter may again enter the abdomen leaving the omentum. The latter may grow fast and later proliferate, in rare cases producing a fatty tumor.

Inflammation may occur in the hernial sac and produce adhesions of the contents, or there may be inflammatory adhesions and constriction at the neck of the sac. If the cavity be empty, and the neck becomes obliterated, a cyst may be produced.

Collection of feces

Adhesions in a hernial sac very frequently cause *incarceration* of the hernia; or make a reducible hernia irreducible. Incarceration may be due to increase of contents of the sac, additional coils having protruded or an irreducible hernia becoming inflamed. The consequences of incarceration are (1) obstruction of the bowels, or (2) from constriction about the neck of the sac, venous stasis, the veins being more readily compressed than the arteries; and perhaps gangrene.

Diverticula occur very frequently (*a*) just above strictures. (*b*) A curious form is seen on the mesenteric side of the gut—that is, at the attachment of the mesentery. There are apt to be several pouches, and on careful examination they are found to contain no muscle fiber. They may consist only of the mucous coat pushed out between the muscle fibers. The cause is unknown. (*c*) The diverticulum of Meckel is found about a ~~half~~-meter above the ileo-cæcal valve, always opposite the mesenteric attachment, and is single. It may be of considerable size, and is due to some abnormality in the connection of the intestinal canal with umbilical vesicle of the embryo.

Volvulus is twisting of the intestine on its axis in all sorts of ways, so that there may be complicated knots, etc. The same results may follow as in incarcerated hernia. disturbs Circulation

Invagination or **Intussusception** is a condition in which one part of intestine is pushed into the portion in advance. It is most frequent at the ileo-cæcal valve, the valve itself being pushed into the large intestine, and not, as is often said, the small intestine into the large through the valve. Symptoms like those of incarceration occur from obstruction of the gut and of the circulation, and sloughing or gangrene of the invaginated portion may result. Intussusception is especially frequent in children.

MORBID CONDITIONS OF THE INTESTINES.

1. Inflammation of the Mucous Membrane.

Catarrhal inflammation is generally due to some irritant material in the intestinal contents. The same causes of irritation occur as in the stomach. Bacterian activity in the contents of the intestine gives rise to various poisonous substances. This has been especially determined in the case of altered milk, cheese and meat. Besides these causes, there may also be the direct irritation of disease germs, as those of cholera and the like.

The mucous membrane is swollen and soft, and covered with serous, mucous or purulent exudation. When serous exudation is present the epithelial cells are washed off to a great extent by the exudate; often they have undergone *degenerative changes resembling hyaline degeneration, but not identical with it.* In other cases there is abundant mucus, the cells undergoing mucoid degeneration much more rapidly than in health. At the same time, as in every form of catarrhal inflammation, there is shedding of epithelium. Finally, there may be true purulent catarrh; and in these cases, together with the desquamation of epithelium, there is exudation of leucocytes and proliferation of connective tissue cells between the glands of Lieberkuhn. The last occurs to a slight extent in every variety, but is marked in purulent catarrh. The pus finally appears on the mucous surface.

Redness may be uniform, or there may be distinct injection of individual blood-vessels.

Follicular Inflammation. The solitary follicles may be obscured by the inflammation, or may be particularly involved, when they become prominent. This is called *follicular inflammation*, and may terminate in follicular ulceration, the ulcers being small and deep. The ulcers present a further peculiarity in being much larger at the base than above, where they open into the bowel by a small perforation. In the later stages the ulcer may spread, and loses its outline.

Follicular inflammation may also involve Peyer's patches, which become considerably raised and swollen, *the surface being red and smooth*, and thus distinguished from typhoid fever, in which the patches are irregular and pale on the surface, or ulcerated. Peyer's patches may also ulcerate in follicular inflammation, but in these cases individual follicles in the patch break down—rarely the whole.

The general causes of catarrhal inflammation may cause any variety, but the follicular form is commonly due to infectious diseases,

Redness is not a characteristic symptom of acute Catarrhal Inflammation.

suppuration of the sub-con. tis. is another form
of inflam. found in stomach but is ra

especially diphtheria and scarlet fever, the lymphoid element in the intestine as elsewhere being specially involved. In these cases, too, there is a tendency to involvement of Peyer's patches, especially in diphtheria, but there is no great tendency to ulceration.

Coagulation necrosis may occur in the mucous membrane in cases of catarrhal inflammation. Such cases are spoken of as "diphtheritic" or "croupous," though the diphtheria bacillus has rarely anything to do with the process. Mineral poisons may be the cause, but generally the ætiology is obscure. The coagulation necrosis may cause a fibrinous membrane on the surface, or may involve the cells themselves, and these becoming discharged ulcers result. Such changes are especially frequent in the large bowel, and as a rule in connection with dysentery.

Age. Catarrhal inflammations of the intestines are most frequent in children, and particularly the follicular variety.

Terminations. The usual termination is in recovery. Sometimes, however, a chronic hyperplastic condition of the mucous membrane or atrophic conditions may result. The atrophic changes are quite common, and present sclerotic connective tissue in place of the atrophied glandular structure. The surface may be smooth,or if contraction of the cicatrical tissue occurs, puckering or even obstruction of the intestines may follow. Areas of healthy mucous membrane may be found between the atrophic patches, and these healthy portions may become *hypertrophic* and *polypoid.* Such polypoid changes are especially frequent in the large intestine and rectum; the atrophic areas alone in the cæcum and ascending colon.

Suppurative Inflammation of the Submucosa is a process distinct from mere suppurative catarrh. Small or large collections of pus are found in the submucosa, and there may be rupture and discharge into the peritoneal cavity, or into the gut.

2. Inflammations of Special Localities.

1. *Duodenal Catarrh* is distinguished clinically by symptoms different from those met with in general catarrh of the intestines. The biliary apparatus is easily involved and gives rise to distinctive symptoms. Duodenitis is generally associated with dyspeptic conditions, and tends to remain chronic.

2. *Typhlitis* is inflammation about the cæcum, and is generally due to irritant matters in the cæcum. The irritants may be products of fermentation within the cæcum, or foreign matters, ingested with

rtal-matter 4 only could foreig matter be found 20 " tuberculosis
5 " Diphtheritic inflam of larg. intestine
4 " typhoid fever
3 " Carcinoma
2 " Cancer of megla bone
1 Strangulated hernia

the food, or even abnormally hardened fæces and the like. Catarrhal processes must be very common in the cæcum, for at almost every autopsy we find atrophic patches in the mucous membrane, the consequence of old localized catarrh. If intense, typhlitis causes ulcers, and then, by extension, inflammation around the cæcum—*perityphlitis*. The latter may lead to abscess, or may terminate in resolution, the latter being most frequent. Perityphlitic abscesses may open externally, or into the gut or into the peritoneal cavity, causing general peritonitis. The bacillus coli communi a frequent cause

The primary source of trouble in these cases is often the *appendix*. This small pouch, rarely having a mesentery of its own, must derive its blood supply entirely from above—that is, from the cæcum at its root—and therefore any obstruction or pressure upon it interferes entirely with circulation in its distal portion. On this account any accumulation of material in the appendix obstructs its circulation partly or wholly, and leads to ulcerations or inflammations of the mucous membrane or gangrene, and rupture is not infrequent.

3. *Proctitis* is inflammation of the rectum. Chronic forms are of especial importance, as they lead to hypertrophy—polypoid excrescences—and not rarely ulceration. There is here also a tendency for the inflammation to extend to the tissues around the gut, causing *abscesses* around the rectum. Such are generally due to the discharge of bacteria and other matters from the rectum into the tissues around. These abscesses rupture into viscera or externally. Very frequently they open externally near the anus—a condition called *fistula in ano*. When not yet ruptured, we speak of *incomplete* fistula; when open, of *complete* fistula, and this tends to remain as a chronic fistulous tract.

Infectious Diseases.

3. Asiatic Cholera.

Morbid Anatomy. An intense, acute catarrh of the serous variety, with copious discharges, carrying epithelium in shreds or as individual cells—the cells having first undergone a peculiar degeneration somewhat resembling hyaline, at any rate not mucoid. These discharges, from their peculiar appearance, are called "rice-water discharges." The *serous surfaces*, and less markedly all parts of the body, except the mucous surface of the intestines, are peculiarly dry at autopsy. The mucous membrane is swollen and red, and covered with the rice-water discharges. Later it may undergo various changes. The des-

The stain for cholera bacillus is a weak sol of Carb-fuchsine.

quamation affects the cells of the surface and also of the follicles. The follicles may become particularly involved, and may undergo necrosis and ulceration. Even Peyer's patches may be ulcerated, and may simulate those of typhoid fever. The latter is seen especially in cholera in the "stage of reaction."

Microscopically, round cell infiltration may be found even in the earliest stages, but becomes marked later on.

Cholera Bacillus. Comma Bacillus. Vilrio of Cholera.

The micro-organism designated by the above names is a *spirillum* which looks like a comma under the microscope. The curve or twist is not, however, on one plane as would seem, but with high powers and careful focusing may be seen to be like a segment of a corkscrew, therefore a true spirillum. When developed under unfavorable circumstances, it grows as long cork-screws, which are made up of many segments.

It is *actively movable*, as may be seen in "hanging-drop" cultures, and by the special stain of Löffler is seen to have one or sometimes two cilia at *one* end. It is *short* and a little *plump*. It grows at the temperature of the body or at that of the room, but is easily destroyed by drying, heat and acids. It is important to know that it may live a long time in water, even if sterilized or distilled; but when the water is contaminated with other micro-organisms it easily succumbs. It has been found and cultivated in the water of cities where cholera prevails.

Cultivation. The most characteristic appearances are seen in gelatine plates and in stab cultures on gelatine. These appearances must be studied closely, for many micro-organisms resemble this one in being comma-shaped, etc. In normal intestinal contents [illegible]

On *gelatine plates*, after two or three days, we find the colonies looking very much as if the surface of the gelatine were covered with little air-bubbles. This is due to little cup-shaped depressions, which are brought about because the micro-organism liquefies gelatine, but so slowly that the moisture evaporates. Examined with a low power, these colonies are seen to have an irregular outline, sometimes like a leaf, and its surface looks as if covered with fine glass-dust or crystals. Moreover, on close examination, the glass-dust moves about actively.

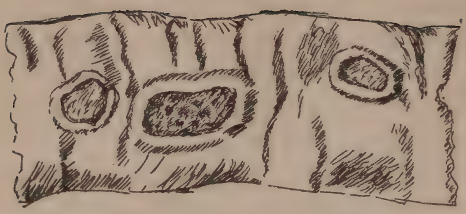
In *stab culture* in gelatine there is the same liquefaction of the gelatine and coincident evaporation all along the track of the needle-stab; and as the organism grows best where there is abundant air, the liquefaction and evaporation are more marked at the top. In consequence, we see by the fourth or sixth day a peculiar appearance—that of a fine capillary tube, blown out at one end.

The *diagnosis* of a culture of cholera bacillus may be readily accomplished by a chemical test. If ten drops of concentrated sulphuric acid be added to two teaspoonfuls of bouillon or other culture medium containing a pure culture of cholera bacillus, a rose color, gradually deepening to purple, is produced. The cholera bacillus is the most aerobic of the intestinal micro-organisms, and therefore a pellicle is formed on the surface when it is present. As soon as this appears, the sulphuric acid should be introduced. Now this test is nothing but the *indol-reaction*, and other organisms besides cholera produce indol; but cultures of no other organism give the reaction, because *nitrites* must also be present, and the cholera bacillus is the only bacterium producing indol and nitrites at the same time.

Seat. The micro-organism occurs in large numbers in the discharges, and in the early stages is found here almost in pure culture. It is also found in the mucous membrane, but has no tendency to pass beyond this into the lymphatics, etc. It is frequently found in groups under the epithelium of the glands of Lieberkuhn, especially at the bottom of the gland.

Pathogenicity. The comma bacillus is the *cause* of cholera, and inoculations with pure cultures, under suitable conditions, cause the disease in lower animals. The earliest experiments failed because the suitable conditions were neglected. It was found that acids readily destroy the germ, and, therefore, that the contents of the stomach would kill it. Sufficient bicarbonate of sodium being given, the bacillus was insured escape from the action of the gastric juices. Next it was found that the peristaltic action of the intestines hurried the bacillus along before a chance had been given for infection, and to obviate this opium was administered. Both of these conditions having been supplied, and a pure culture introduced by the mouth, cholera was readily induced. The germ must be introduced into the intestinal tract, for its action is entirely local and not through the blood. The general symptoms of the disease are produced by poisons, elaborated within the intestines by the action of the bacillus.

4. Typhoid Fever presents characteristic lesions in the intestines,



especially in the lower part of the ileum near the valve, less marked upward in the small and down the large intestine. The bowel shows general catarrhal inflammation, together with a *special cell proliferation and specific necrosis of the lymphoid tissues of the mucosa.* There is at first general redness, with intense congestion about Peyer's patches and the solitary follicles, sometimes especially about the latter. At the same time there occurs swelling of Peyer's patches, this being irregular and causing a finely convoluted surface. This unevenness is due to the fact that connective tissue bands running through the patch are not involved in the hyperplasia which affects the lymphoid elements between the trabeculæ. As the swelling increases the redness diminishes, and a gray-colored patch results; and finally a peculiar necrotic change, not coagulation necrosis nor suppuration, occurs, and the *typhoid ulcer* is the consequence. After the swelling and hyperplastic changes in Peyer's patches have begun, there is also evidence of inflammatory changes about them, as evidenced by round cell infiltration and proliferation. These changes may extend deeply—even to the serous coat—and the necrotic processes may affect these masses of cells at the same time as Peyer's patches.

Necrosis occurs about the latter part of the second week, and in the beginning of the third the necrotic areas are cast off. The resultant ulcer has the shape of the patch—hence usually with its longest axis along the gut—has thickened edges, and heals from the floor and edges. Where there has been extensive destruction there is not complete regeneration of mucous membrane, but, instead, a shallow covering in the ulcerated area. Extensive surface or deep ulcerations occur particularly about the ileo-cæcal valve.

Perforation and **Hemorrhage** are the results of deep extension. The former is usually prevented by inflammatory connective tissue formation on the serous coat. When perforation does occur it is usually by a small orifice, for the necrotic processes become less widespread as they pass outward from the mucosa. Hemorrhage results from ulceration of the walls of the blood-vessels, no thrombi being formed to prevent its occurrence.

Mesenteric Glands. The same processes of hyperplasia of the lymphatic elements occur here as in Peyer's patches, and necrosis may result—perhaps rupture and peritonitis, but this is rare.

Spleen. "Acute splenic tumor" is common in typhoid fever, and in perhaps a majority of cases the spleen is double the normal size. (For details see diseases of the spleen.)

Necrotic processes may occasionally also occur in other situations. There may be small abscesses or large "cold" abscesses. The ætiology of these abscesses is in doubt, some claiming infection by micro-organisms of suppuration, while others maintain that the typhoid bacillus itself may occasionally cause suppuration.

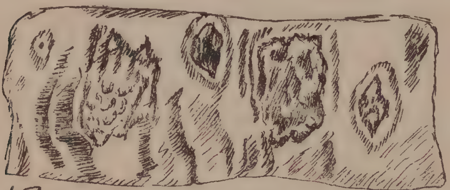
Ætiology. The cause of typhoid fever seems to be a bacillus, but the proofs are not so conclusive here, for the crucial test of producing the disease in lower animals has never been satisfactorily demonstrated. Still, it is generally believed that the bacillus causes the disease.

This bacillus is about the length of the tubercle bacillus, though often somewhat longer, but thicker and somewhat bulbous at the ends. It is motile, having cilia along the side, and moves in a serpentine manner. There are certain clear spaces within which do not stain, and from these there is often an appearance as if parts or the end of the bacillus were bitten off. It stains readily, but just as readily loses the stain, and there is no special and characteristic method of staining. Löffler's solution of methyl blue may be used, water being used to wash out excess of color, and not alcohol, since this quickly decolorizes the bacillus.

Cultivation. The characteristic growth is obtained on potatoes. To the naked eye the potato looks as if slightly moist, and presents no apparent colony. On scratching with an öse, however, this moist appearance is found to be due to a transparent, tough pellicle.

The bacillus grows readily in milk and water, and is generally introduced in this way. It is found in the intestinal contents, the lesions, the mesenteric glands, and in the spleen. It is present and may be found in every case during the first eight days. It is very difficult to demonstrate the bacilli in the tissues, but fortunately for diagnostic purposes they are usually arranged in large groups, and in staining with Löffler's solution large blue masses are seen with low-power lenses. If the edge of such a mass be then examined with the immersion lens, separate bacilli may be found. It is almost useless to examine specimens from cases after the eighth day.

The *Bacillus coli communi*, a normal bacterium of the intestinal tract, has excited much attention of late, and it is by some regarded as identical with the typhoid bacillus. These investigators would make out a case similar to that in regard to the pneumococcus, which exists normally in the saliva. The weight of evidence is against these assertions, and it is possible to demonstrate certain differences between the two germs. The *Bacillus coli communi* elaborates lactic acid, but the typhoid bacillus does not. This may be readily shown by adding sugar of milk and litmus to agar, and inoculating tubes with each bacillus. The *B. coli communi* will, under these circumstances, elaborate lactic acid, and change the litmus to a red color, while no such result occurs in the other tubes.



5. Tuberculosis also tends to involve the lymphatic tissue particularly, and presents characteristic lesions. There is first cellular infiltration, then cheesy degeneration, rapid breaking-down and formation of ulcers. The ulcers are, as a rule, more irregular than those of typhoid fever, and if at all extensive their long axis is transverse to the axis of the intestine. The tubercular process first involves certain lymphatic patches and extends from these in breadth and depth. Tubercles or cheesy nodules may be seen in the edges and bottom of the ulcer; and if the process has extended deeply the lymphatics of the peritoneum are involved, and tubercles may be found along their course toward the mesenteric attachment. In typhoid ulceration no such serous involvement is present.

Is very common

Tubercular ulcers rarely cicatrize, probably because the individual usually dies before such could occur.

They are brought about by swallowing of tubercular material—very frequently sputum in lung tuberculosis.

The *seats* especially affected are the ileum and the region of the valve. The upper part of the large intestine is less frequently involved, but the rectum, near its outlet, is a not unfavorable locality, and here, too, the greatest tendency to perforation is manifest. The ulcers of the small intestines rarely perforate, but in the rectum such a result is not at all infrequent, and often leads to periproctitis, suppuration and fistula.

The serious surface is very liable to be involved. Yet they have no tendency to perforate as in typhoid.

He thinks that all cases of primary tuberculosis tubercles were also found in the intestine.

6. Syphilis. Acquired syphilis of the intestines, excepting about the anus, is rare in the adult, and rather doubtful. In the new-born gummata may be found, involving rather wide areas, especially in the jejunum, and leading to cicatricial contractions. The *sphincter ani* is a favorite seat, especially in women, for acquired syphilis. Infection by vaginal discharges seems to be the cause in many cases in women. There may be marked ulceration, extending out to the neighboring skin and formation of cicatrices. Great thickness of the gut is characteristic.

7. Dysentery begins as a catarrhal inflammation affecting the lower bowel from the cæcum to the rectum, and attended by production of much mucus. The mucosa is red and swollen, hemorrhagic and covered with blood-tinged mucus. Later there is tendency to suppuration, with loss of substance—that is, the formation of ulcers. In mild cases only the crests of the elevations of mucous membrane are involved, these cases being called “1 Catarrhal Dysentery.” In severe or 2 Diphtheritic Dysentery” 3 and Gangrenous Dysentery extensive necrosis, having the characters of coagulation necrosis, but not otherwise related to diphtheria, occur, and present a grayish coating or pultaceous or even extensive gangrenous patches on the mucous surface. The dead parts may be discharged in mass by ulceration beneath.

Termination. Complete healing is generally the result in this latitude, except in epidemics. In other cases, after grave dysentery, there may be considerable destruction and removal of mucous membrane, and in consequence a worm-eaten appearance. Between these patches of atrophy there may remain islets of healthy mucosa, which later on may become hypertrophied and produce polypoid outgrowths. There is often excessive connective tissue formation with production of scars, strictures and the like.

Ætiology. It is very probable that several different forms of infection may cause dysentery, and this is not suprising when we consider the great number and variety of intestinal micro-organisms. On this account, also, it is hard to isolate the specific germ and to prove its pathogenicity.

A protozoan organism, the *Amœba coli*, is now regarded as the cause of a form of dysentery especially prevalent in the tropics, and no doubt many cases are so produced. But it has not been shown that all cases of dysentery are of this nature. The *Amœba coli* is a protoplasmic mass, with a clear outer zone and a more granular inner

The amoeba coli is much larger than W. B. C.

In this latitude those cases of Amoeba Coli is a form that is very alarming. There is a amoeba in the normal intestine that is so near like this amoeba coli that we can not tell the difference.

portion, and varies in size from fifteen to thirty micromillimeters, therefore several times the size of a leucocyte. It has a nucleus and one or more clear spaces or vacuoles filled with clear fluid. Spherical when at rest, it assumes various shapes when moving, by its amœboid motion, which consists of the protrusion of a process or *pseudopod* from the clear outer layer of the organism, and subsequent flowing into this process of part of the granular matter within.

Examination and Cultivation. It is always best to examine the stools while still warm, for as soon as cold the amœboid motions stop, and examination is difficult. Portions of the mucus streaked with blood should be selected, and are often found to contain enormous numbers of amœbæ. The organism has been cultivated in hay infusions, and the disease produced in cats and dogs by injection into the rectum of portions of such cultures, as well as of the stools themselves.

Anatomical Distribution. In the intestines the amœbæ have been found in the bowel wall, and there produce the inflammatory changes. Further, they penetrate into the lymphatics, and may even be found at some distance in secondary lesions, as in liver abscesses. If amœbæ were present in the dysentery that preceded the abscess, they may always be found in the contents and walls of the latter.

It is a common view that dysentery is most common in warm countries, but the warmth itself has nothing to do with it. There are portions of the American tropics where dysentery is a rare disease, and in general there is much less in our tropics than in India. The disease abounds wherever the organisms are found. It has grown much less common and less severe in our Southern States than it used to be.

8. Tumors of the Intestines.

(*a*) *Adenoma* may be *polypoid*, and follow ulceration and similar destructive processes in the intestine. The islets of healthy tissue undergo proliferation, with formation of new glandular tubules, and in short adenomatous overgrowth of polypoid shape.

Flat Adenomata also occur, especially in the rectum just above the area of squamous epithelium, which extends some little distance above the anus.

(*b*) *Carcinoma* is generally primary, the secondary being rare. The most frequent seats are the rectum, the cæcum and the two flexures of the colon. It is rare in the small intestines, occurring in them most frequently high up in the duodenum, about the mouth of the biliary and pancreatic ducts.

Cancer may appear as fungoid masses or as polypoid outgrowths. In either case there is tendency to early ulceration. The cells are cylindrical-shaped, quite regular, and generally nicely arranged in cylinders or tubules, thus resembling adenoma very closely. The border line between adenoma and cancer is therefore very hard to define.

Squamous Epithelioma is the common form about the anus. It appears as nodes or as extensive papillomatous tumors.

Intestinal cancer gives metastasis quite readily, the secondary nodules appearing in the mesenteric or retro-peritoneal lymph-glands, the liver, or the peritoneum. Cancer of the lower part of the rectum may give metastasis to the inguinal glands.

THE LIVER.

Anatomy. In the center of each lobule or acinus is a vein—the "central vein" of the lobule. Around this, arranged in a somewhat radiating manner, are the hepatic cells—large cells containing a vesicular, large nucleus and granular contents. Around the lobule are found the portal veins, the hepatic artery, lymphatics and bile ducts, all bound together by connective tissue, not in great quantity except in the larger interlobular spaces. There are two distinct currents of fluids in the liver, the blood moving from the periphery toward the center of the lobule to enter the hepatic vein and the lymph and bile flowing in the opposite direction toward the perilobular vessels.

Functions. (*a*) The liver elaborates bile, which takes some part in *digestion*, as it contains a fat-emulsifying substance, a diastasic ferment, aids in dialysis of products of digestion through the intestinal walls and stimulates peristalsis.

(*b*) The liver further has important *nutritive* functions, which are only partly understood. The liver cells contain a substance called glycogen, which is converted into glucose by the action of a ferment in the blood. This is a normal process, but there is no excess of sugar formed, and by some means the sugar is rapidly destroyed, so that no excess occurs in the blood. But in certain pathological conditions, in diabetes, for example, there is excessive formation of sugar, probably because the blood remains longer than normally in the liver, on account of dilatation of the vessels, and because the processes of oxidation by which sugar is destroyed under normal conditions fail to take place. Therefore the blood is surcharged with glucose, and it appears in the urine.

(*c*) There are also certain *eliminative* functions, which likewise may become deranged, producing disease.

MORBID PROCESSES IN THE LIVER.

1. Congestion may be *active* or *passive.*

Active Congestion occurs almost physiologically in over-eaters. Also, it occurs in diabetes, and probably the diabetes due to injury of the floor of the fourth ventricle is due to congestion of the liver. This may also be produced by cutting sympathetic fibers near the liver.

Passive Congestion is an early result of obstructive heart disease, since the hepatic vein empties almost directly into the right heart. Lung disease acts almost exactly the same way. The first result is overfilling of the central vein of the lobule, the surrounding lobule presenting various appearances, according to the changes which have taken place. Very frequently fatty change occurs, and in consequence there is presented a dark center and light-colored, yellow periphery, an appearance often called "Nutmeg Liver" or "Fatty Nutmeg." In other cases there may be atrophy, either as an early or primary change, or secondary to the fatty change described. In these cases there is a dark center and grayish color around from the atrophy of the parenchyma, leaving only the connective tissue. In still hoter cases there may be congestion also of the peripheral portions of the lobule, and some deposition of blood pigment. The cases in which there is atrophy of the parenchyma are called "Atrophic Nutmeg," and they present not only a relative increase of connective tissue from atrophy of the parenchyma, but also an active hyperplasia of existing connective tissue, as evidenced by round cell infiltration.

2. Acute Suppurative Hepatitis. Abscess. Abscess is the only form of true acute inflammation.

Abscess may (*a*) be due to wounds, with infection from outside; (*b*) to extension from neighboring structures, as from the peritoneum, the abdominal organs, or the pleura; (*c*) from infection along the bile ducts, after obstruction of the latter by bile stones and the like, and infection from the intestinal tract. All of these are rare methods, but (*d*) pyæmic or hæmatogenous abscesses are much commoner. (*e*) The *abscess of the liver*, peculiar and distinctive, is usually due to dysentery, very frequently from amœbic infection. It is generally a large abscess, deep-seated, and usually solitary, very rarely consisting of over two or three pockets, the pyæmic, on the other hand, being usually multiple and near the surface of the liver.

Histologically, it is the same as abscesses elsewhere, but in the walls and contents large numbers of amœbæ may frequently be found. Abscess of the liver occurs wherever the amœba abounds; it is much commoner in India than in tropical America, and probably is no commoner in our Southern than in the Northern States.

3. Acute Yellow Atrophy is an acute disease of very short duration, characterized by rapid fatty degeneration, breaking-down and removal of the degenerated cells.

Macroscopically, it is a small liver, perhaps only one-half the normal size, very soft, sometimes almost fluctuating, and of varying color, some parts being always yellow, but others reddish from congestion.

Histology. Intense fatty degeneration is prominent, and in consequence the cells become more and more indefinite in outline, until they lose their normal appearance entirely. The oil granules run together into droplets, or may present fine granules. Finally, as the fatty matters are removed, the organ becomes reduced in size until it is quite small. The areas of red color are often prominent, and are due to congestion, hemorrhages and the deposition of blood pigment. Indeed, the large amount of blood seen in sections, even in the yellowish areas, is characteristic of acute yellow atrophy. The liver is always soft, and may be almost fluctuating.

In some cases, in which there is a tendency to chronicity and to cure, there is round cell infiltration, as an evidence of the attempt at regeneration. This occurs only in slow cases, and late in the course. In the fatty detritus may be found leucin and tyrosin, also quite characteristic of this disease, The crystals are seen in the fatty matter, and may be quite abundant.

Ætiology. The cause is doubtful, though from the mode of onset, the fever, and the occasional tendency toward having several cases at a time or in succession (mild epidemicity), we may suspect *infectious agency*. Sometimes, indeed, it is associated with pyæmias, septicæmias and the like. There is also some association with *preg-*

nancy; and in poisoning by *phosphorus* and *arsenic*, especially the former, a similar condition of the liver is produced, though not of so rapid a course.

4. Chronic Interstitial Hepatitis or Cirrhosis is a condition characterized by overgrowth of connective tissue. This process involves mainly the connective tissue between the acini, and when the acini themselves are involved it is their peripheral portions that suffer, the center generally remaining entirely healthy. The lesions encountered are—(1) round cell infiltration, (2) formation of new fibrous tissue, (3) multiplication of biliary passages (increase both in size of the existing and in their number), and (4) atrophy of the hepatic cells. The latter of course occurs in the acini, but in their peripheral portions.

Two views are held in regard to the method of occurrence of scleroses of organs. 1. It is maintained by some that the cells first atrophy and are removed, when the connective tissue becomes *relatively* excessive, or new connective tissue is formed in addition. 2. Others hold that the connective tissue hyperplasia is primary and followed by atrophy of the cells, in consequence of pressure of the new-formed fibrous tissue. In all probability, both theories are correct, some cases being produced in the first, others in the second mode.

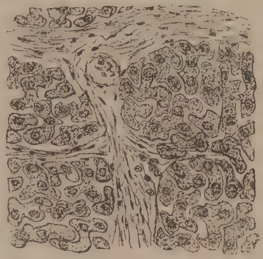
Thus there is no doubt but that in phosphorus poisoning the cells first atrophy, after which the connective tissue is relatively in excess, or actually so, by subsequent hyperplasia. So too in obstruction of the bile ducts, the pressure exerted by the distended biliary passages on the liver cells causes atrophy of these, and connective tissue hyperplasia follows. The same is true in other forms of pressure, as in tight lacing, pressure of tumors, etc.

On the other hand, in ordinary cirrhosis, the disease so-called, unquestionably the primary change is connective tissue hyperplasia, the atrophy of the parenchyma following secondarily.

Ætiology. The cause of the connective tissue overgrowth is generally an irritant brought to the liver in the blood of the portal circulation. This irritant is mostly some ingested matter or a product of digestion of such. The most common and powerful of these is alcohol. In other cases the irritant is not known and in these instances the cirrhosis is merely a part of a general fibrous change all over the body and affecting particularly the arteries, the kidneys, liver and heart. Curiously, in this process of general fibrosis the connective tissue of the nervous system, the neuroglia, is hardly ever involved, and in cases of sclerosis of the nervous system there is scarcely ever found any tendency to general fibrosis. This lends some color to the claim that the neuroglia is not a connective tissue. These widespread fibroid changes are also due to some irritant circulating in the blood, and are favored by old age.

Varieties. Atrophic and Hypertrophic.

Atrophic Cirrhosis is characterized by a persistent overgrowth of connective tissue which tends to become cicatricial in character. These changes are marked between the acini, and there is very little tendency to penetrate into them. The first stage of the process is round cell infiltration, and there must be some enlargement of the affected part, but the process is so slow that while one part is enlarged a neighboring is diminished in size, and there is never at any stage general enlargement of the organ. In the late stages there is always diminution of the size of the organ.



Atrophic Cirrhosis.

Macroscopically, we see in the center of the lobules the normal yellow-colored liver cells, surrounded by a zone which presents a grayish appearance from new-formed connective tissue. In somewhat later stages the surface presents a granular appearance from contraction of the connective tissue about the acini pressing these upward. In other cases several acini may be surrounded by connective tissue bands which in contracting give rise to an uneven surface. The term "hob-nail liver" is applied to such cases.

On closer examination the connective tissue bands are found to be rich in blood-vessels, and in round cell infiltration, even in the later stages. There is, moreover, hyperplasia of the bile ducts, though probably not so abundantly as some have thought. Probably the rows of cells taken to be new-forming bile ducts are often merely the polygonal liver cells caught in the meshes of the fibrous tissue. No doubt, however, there is some new formation of bile ducts.

Results. The new formation of connective tissue begins about the portal vessels and affects them particularly, causing constriction and congestions in the peripheral portions. To this fact are due all of the symptoms of the disease outside the physical signs. Thus congestion of the intestinal mucosa and dropsy of the peritoneal cavity result, and disturbance of special veins which try to carry on the circulation in place of the obstructed vessels. The portal vessels are not alone constricted by pressure from without, but there seems also to be some hyperplasia of the endothelium of these vessels.

The hepatic artery and its branches are not involved, and the hepatic ducts are not obstructed, hence there is very rarely jaundice.

Poor name

Hypertrophic Cirrhosis is an entirely distinct disease, and has nothing to do with *atrophic cirrhosis*. There is little tendency to formation of cicatricial fibrous tissue, but the proliferated cells remain in their embryonal state. There is from the first enlargement of the organ, and no tendency to subsequent diminution.

The hyperplasia is the result of repeated subacute attacks at varying intervals—attacks accompanied by pain, fever, renewed enlargement of the organ, and jaundice. With each attack a new crop of connective tissue is formed, and remains without tendency to contraction. *Hypertrophic cirrhosis is never an early stage of the atrophic form*, and the liver never becomes reduced in size unless by cure, and this is very rare.

The appearance is that of an enlarged, smooth, hardened liver of normal outline and usually dark green in color, though light green when fatty change occurs. The cells are generally pigmented with bile pigments.

Microscopically, round cell infiltration is prominent, with only here and there a fine fiber of connective tissue. There is also a tendency to penetrate into the acinus between the liver cells, but little formation of connective tissue results. New formation of bile ducts is more pronounced than in the atrophic form.

Results. There is no obstruction to the portal circulation, but on the contrary increased facilities seem to be offered to the circulation, the hepatic artery and portal vein both being enlarged. There is, therefore, no dropsy or other circulatory disturbances.

The bile ducts are, however, generally pressed upon, and jaundice is common.

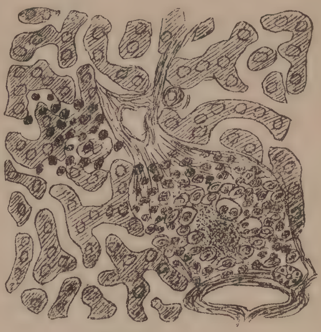
Hypertrophic cirrhosis is more common in the Southern States, but is probably commoner everywhere than is believed.

5. Infectious Diseases.

Syphilis. Of the viscera the liver is one in which acquired syphilis most frequently manifests itself. Gumma occurs as a lesion

Tuberculosis in liver is rare.

of hereditary or acquired syphilis, and is distinguished by the bands of connective tissue radiating from it like the spokes of a wheel.



Tubercles in the Liver.

Tuberculosis seldom becomes conspicuous in the human liver, therefore rarely cheesy nodes. There are small miliary tubercles, which may only be well demonstrated by the microscope.

6. Tumors of the Liver. Primary tumors are rare; the secondary comparatively common.

(*a*) *Adenoma* is one of the commonest primary growths. It is generally multiple, and as a rule small, scarcely ever exceeding the size of a cherry. It is usually near the periphery rather than at the center. The color is gray, or if vascularity is increased, reddish. *Microscopically*, we see coils of tubes composed of epithelial cells. This is striking because the liver does not present the appearance of a tubular gland, though in reality it is such, as may be seen in some of the lower animals, and even, on close study, to an extent in the adult human specimen.

(*b*) *Cystic Adenoma* also occurs, and is multiple, but may be much larger than the simple adenoma. It springs from the small mucous glands of the bile ducts.

(*c*) *Cancer of the Liver* is comparatively rare as a primary growth, but common as a secondary, in comparison with other abdominal viscera.

Primary Cancer appears in three forms:

1. Single masses, circumscribed and rounded, presenting very much the appearance of secondary growths. When metastasis occurs the secondary nodes are found also in the liver and close around the primary growth—therefor[illegible] a local metastasis.

2. Diffuse cancer, cancer with cirrhosis, or cirrhotic cancer, are terms defining a variety in which there is much the appearance of cirrhosis of the liver, and in which indeed there is actually cirrhosis, overgrowth of connective tissue, in the meshes of which grow the cancer nests. The disease is distributed uniformly throughout the organ.

3. ~~Per~~iportal cancer is that in which there is a tendency to the development of cancer around the portal vein, beginning at its en-

trance into the organ, and presenting the largest mass at this point, and thence extending along this vessel to its remotest branches. It may be distinguished from the cirrhotic form by the fact that it begins at the large vessels and extends to the smallest, whereas the diffuse form is more apt to be first found in the connective tissue between acini in the region of the smallest portal veins.

Cancer of the liver usually presents cells of no definite shape—that is, they are polymorphous; but occasionally cancers containing only cylindrical cells are met with.

Secondary or Metastatic Cancer usually appears as well circumscribed nodes of whitish-gray color, standing out prominently against the darker liver substance. If small, the node may have no capsule; but when the size becomes greater the capsule usually appears. Not infrequently softening occurs in the center, and in consecuence the surface of the growth becomes "umbilicated," an appearance also found occasionally in primary cancers of the first variety (single mass), but is far more frequent in secondary.

Metastatic cancers of the liver are generally secondary to primary growths of the stomach, and in this case are of the appearance described; but when metastasis comes from some other primary focus, as in the breast or œsophagus, a different appearance results. In this case an "infiltrating" growth occurs. This differs from the other form of secondary growth in growing peripherally and pushing its way out in all directions, and not centrally, as do the ordinary metastatic deposits. The infiltrating form is therefore not encapsulated.

(*d*) *Sarcoma* is rarely primary. Of secondary forms the melanotic is most important. The liver is the favorite seat of secondary deposits of this growth; and in primary pigmented sarcoma of the eye, if metastasis has occurred at all, we are sure to find some in this organ. The secondary deposits are the same kind of sarcoma as the original, and are also melanotic. In rare cases there may be a sort of double metastasis, some of the secondary nodes being pigmented, others not. Generally there is also involvement of others of the abdominal viscera at the same time.

(*e*) *Angioma* is the commonest of the simple tumors of the liver, and is of the cavernous type. It occurs especially in old people and does not interfere with the function of the organ, therefore is rarely suspected during life. It is usually small, rarely above the size of a walnut; is dark in color; and more frequently on the periphery of the organ. It is distinctly circumscribed and usually multiple, but rarely more than two or three. The nature is readily determined.

(*f*) *Fibroma* is quite rare. A few cases of *neurofibroma* are reported. These are fibroids extending along the nerves of the liver.

THE BILIARY PASSAGES.

1. Biliary Calculi. This constitutes the most important disease-condition. The calculi are most frequently found in the gall-bladder, but may be elsewhere in the passages, high up or near the outlet in the intestines. In size they vary from minute granules to large masses. They may be single, when they are round and smooth, or multiple, when they present facets from mutual pressure. In color they vary from a light yellow to a deep greenish-black. The center, even in the light-colored ones, presents a dark nucleus, which is surrounded by lighter areas and generally with a crystalline appearance and radiating arrangement. The center or nucleus is composed of hardened bile, and the whole stone may have this condition, but generally the outer layers are composed of cholesterine.

especially advanced life

Causes. Stagnation of the bile in its passage to the intestines is the most frequent cause. The bile, being retained by various obstructions, becomes inspissated. A primary factor in all cases is a foreign body, which acts as a central nucleus. This may be something from the intestinal tract, or it may be a mass of loosened epithelial cells. Another factor is changes in the bile itself—diminution of constituents which tend to preserve its fluidity. Cholesterine is readily soluble by salts of the biliary acids, and when these salts fail, deposition of cholesterine is apt to occur. Perhaps bacteria have something to do with altering the composition of the bile.

Results of Biliary Calculi. Clinically, pain is the prominent symptom accompanying their passage. The obstruction of the ducts, produced at the same time, causes re-absorption of bile, and jaundice results. The irritation of the calculus also causes inflammation of the walls of the bile ducts, perhaps ulceration or even perforation. By such perforations large calculi may find their way into the gut to be discharged; and this is the only possible explanation of the escape of some of the large stones. Again, perforation may lead into the peritoneal cavity, or even externally.

The bacillus coli communis has been found in the calculi.

The passages above an impacted stone become dilated, and this is apt to cause connective tissue overgrowth, or cirrhosis around the ducts.

2. Inflammation of the Bile Passages.

(*a*) Mild or catarrhal forms are very common, and are due to extension of the inflammation from the duodenum. The mucosa of the ducts may be so much swollen, or mucus may so accumulate, that obstruction and jaundice result. No permanent lesion remains.

(*b*) There may be inflammation, with tendency to suppuration and ulceration. Such may occur in cases of gall stone. In connection with all of these severe inflammations, bacterian contamination is most probably present. The biliary passages are peculiarly exposed to infection by micro-organisms from the intestines, but under ordinary circumstances the bile kills the bacteria. In cases of the kind described, however, there are many organisms in the bile. Possibly, bacteria have something to do with changing the character of the bile, so that gall stones are formed.

As a result of these severe inflammations there may be septicæmia or pyæmia, or there may be cicatricial obstruction, which may lead to cystic changes, or, if the obstruction is near the outlet, permanent constriction, cirrhotic changes in the liver, but finally death.

3. Tumors of the Biliary Passages.

Cancer of the liver not rarely springs from the bile ducts.

Nervous System.

Inf. of m. lining brain and cord called meningitis. May be upon surface of brain or on the membranes.

Internal Pachymeningitis

Pachymeningitis means inf. of dura. ∴ tends to hemorrhage

Lepto meningitis is an acute meningi

of arachnoid and pia mater.

It may occur from pyæmic infecti

or pneumonia, Endocarditis Etc.

The peculiar symptoms in specific disease may be due to an inf of the membranes of the brain. So in typhoid. and is due to microorganisms. and they

Tuberculosis of the brain is quite common and tubercular meningitis is the way it sh itself. We can find the miliary tubercles scattered over the surface It looks like the bo dust Wash carefully so as not to make this mi

Encephalo Meningitis is a deep seated chro trouble. Do not know where it begins. This is found in the insane. Changes in the meninges as thick again as normal.

Spinal Cord

1st Simple atrophy. Early a loss of the prolongations of the ganglion cells They become more rounded and show evidences of degeneration.

Fatty degeneration is 3d form and is like ge of J. D. Anterior horns of cord affected.

The medullated nerve fibres have decreased?

Degenerations Proper

Softening. May be due to softening of tissu obstruction to blood supply causes ischemi

PART II.

Hemorrhagic 1 Infarct
2 Diseased b. v. Sudden disturbance of circulation cau

compression and other cause

First Year Pathology.

as a result of traumatism
" " " " infection Every day becomes more and more apparent. Marked in rabies and tetanus.

We should distinguish softening from suppuration. Pernicious anaemia jaundice, ergotism etc all causes

The medulated nerve fiber is affecte

They become beaded and irregular

The myaline breaks up into droplets. Axis cylinder breaks up into fragments. Months later there is attempts on the part of the neuroglia to repair the process. It is then called sclerosis and the area is called a "sclerotic

The smaller areas are replaced by norma nerve cells.

Secondary Degeneration

Is slower process than the above.
The same thing happens as in softenin only is much slower. Hyperplasia of the neuroglia takes place so we do not have the softening. These degenerations follow special tracts. Is usuall described as ascendi or decending. Ascending degeneration affects the ascending tracts Posterior tract
Weigerts stain stains the medulary fibres black In this disease the medulary tracts are destroyed So this is a sure diagnosis. He means a slide

Multiple Sclerosis.

CHAPTER I.

The study of medicine is divisible into :

1. *Pathology* (the phenomena of disease); and

2. *Practice* (or management of disease), which is the application of this knowledge.

Pathology, then, is that branch of the science of medicine which has for its object the study of the manifestations of energy and changes in structure that take place in the diseased living being.

Disease includes all modifications of the normal manifestations of life which impair more or less the adaptability of the individual for his surrounding media.

A Disease is a certain group of these modifications, so arranged as to make a distinct species.

Divisions of Pathology. *Ætiology*, the study of the cause of disease.

Morbid Anatomy, the study of the changes of structure in disease.

Morbid Physiology, the study of the changes ot function in disease.

(So Biology is divided into Embryology, Morphology and Physiology.)

Further, Pathology is divided into *General* and *Special Pathology;* the former dealing with morbid changes of function or structure occurring in any tissue or organ; the latter with the changes in special organs.

Depending upon the predominance given one or the other of the first three divisions, various schools of Pathology have existed from time to time :

1. *Cellular Pathology*, founded by Virchow, is concerned especially with changes of structure in disease.

2. *Ætiological school*, which relates to cause, and at present is identified with the study of Bacteriology.

3. *Physiological school*, which relates to function in disease, has had no special period of development, its progress being slower since

it relates to the most difficult branch of Pathology. The experiments in physiological therapeutics are efforts in the direction of ideal medicine. Changes of function (from mechanical laws) will bring about changes of structure, and these in turn bring about secondary changes in function, which show themselves as symptoms or phenomena of disease. The trophic influence of the nervous system is especially concerned here.

Divisions of Disease, based on functional or structural changes, are :

1. Functional.
2. Organic or structural disease.

This division is not scientifically correct, from reasons given above, our means of investigation not being exact enough to find structural changes in the so-called functional disease.

MORBID ANATOMY.

Morbid Anatomy is divided into :

1. Macroscopic or Gross Morbid Anatomy ; and
2. Microscopic Morbid Anatomy or Pathological Histology, in which *microscopic technique* is used to examine the structure of diseased tissues.

Lesions are changes or modifications of structure which take place in any organ, hence in its cells, through disease. In Morbid Anatomy we especially study changes in cells, even if not seen by the microscope.

Cells make tissues ; tissues make organs.

For obtaining specimens necessary for the study of the anatomy of disease a *post-mortem examination* of a diseased body is made (autopsy, necropsy), in which both the macroscopy and the microscopy of the altered tissues are considered.

In the microscopy of the normal body it is found to be made up of minute particles of protoplasm called *cells*. In the study of pathological tissues these same elements are dealt with, and the only changes to be noted are found in the structure of the cells, in their positions and relations. In most, if not in all, tissues and organs these cells are grouped into *two* distinct divisions : one set acting as the skeletal part of the tissue or organ, this being known as the *connective tissue ;* and then, held together by this skeleton, the cells peculiar to the organ, known as the *parenchyma*. These two types are clearly distinct in the earliest embryonal life, the connective tissue arising from certain portions of the embryo, the parenchyma from other portions. The part from which the connective tissue arises is called the *Parablast;* that from which the parenchymatous cells arise is known as the *Archiblast.*

In the embryo, then, there occurs at the earliest stages multiplication of the original cell with the formation of many, and these cells arrange themselves in certain layers, giving rise to the arrangement known as the **Blastoderm,** which, in turn, comprises three primary layers of cells, known from their relative positions as *Epiblast*, *Mesoblast* and *Endo-* or *Hypoblast.* These three taken together are known as the *Archiblast.* Outside these, and not strictly belonging to the archi-blastoderm, but growing about the archiblastic tissues and sending prolongations into them, is another layer—the *Parablast.*

From these original layers of cells in the embryo arise all the tissues forming the adult body, and to them may be referred for peculiarities in their growth.

From the **Archiblast** arise:

1. *Epiblast*, which gives rise to the epidermis and its derivations (various skin glands), the terminations of the digestive system (mucous membrane of mouth and anus), and the nervous system.

2. *Mesoblast*, the epithelium of urinary and reproductive systems and smooth and striated muscle fibers.

3. *Hypoblast*, the epithelium of the respiratory and digestive systems.

From the **Parablast** arise the connective tissues generally, the red and white blood corpuscles, the lymph and the endothelial cells.

The relations of these two great classes of cells exist throughout the existence of the organism, whether in the embryonal or adult state. The parablastic cells are either fixed about the archiblastic cells as support (connective tissue) or wander about them (blood corpuscles).

Cells, then, are minute elementary parts of living beings, each one endowed with independent life, capable of self-nourishment, growth and reproduction.

Anatomy of Cells. They are for the most part made up of a *cell-body* and a *nucleus*. The material making up the cell-body is called protoplasm (bioplasm, cytomitome), an apparently slightly granular substance, the granulation being due to the fact that one sees transverse sections of a fine network. In the meshes of this network there exist even finer filaments (looking homogeneous and termed *paraplasm*).

This network (protoplasmic) is motile, and by its movements gives rise to the contractility of the cell substance, a property aroused by external stimulants, as heat or electricity, or by certain unknown internal causes (automatic contractility).

The Nucleus is a portion of the cell surrounded by the cell-body, and usually separated from the latter by a *nuclear membrane* (as the cell itself is generally separated from its surroundings by a *cell-wall*). The nucleus is made up of a *nuclear network*, which is the essential part, and from its special staining properties (with nuclear stains, as carmine, hæmotoxylin, and Bismark-brown) is called chromatine (karyomitom), whose arrangement is not entirely irregular, but follows in a general way a definite plan.

Mitom is a term signifying the essential part of cell-body (protoplasm) or of nuclear network (chromatine). The *nuclear plasma* surrounding the chromatine is called *achromatine*.

Within the nucleus of some cells there exists a *nucleolus* (whose function is not understood), which must not be mistaken for crossing of fibers of nucleus. It is known that the nucleolus disappears when cells multiply, and appears again in the daughter cells.

Chemistry of Cells. The protoplasm of the cell-body is an albuminate, and in certain cells the entire cell substance is composed of this material. In other cells we also have fats, etc. And hence cells may be classified as those having one substance in their constitution (*monoplastic*), and those having two (*diplastic*) or more (*polyplastic*.)

In *diplastic* cells the second substance may arise *within* the cell, from transformation of the protoplasm ; or it may originate *without* the cell, being deposited by infiltration.

The nucleus is also made up of an albuminate, differing from protoplasm of the cell in that it contains an albuminoid (*nuclein*), into the composition of which phosphorus enters. While the nucleus can usually be distinguished from the body of the cell, the microscopist can the better differentiate by the action of the *nuclear stains*, and by acids (as acetic, muriatic), which latter have a peculiar action on cells in that they clear up the cell-body, leaving the nucleus unchanged and opaque, thus rendering it visible.

FUNCTIONS OF CELLS.

Cell Functions are assimilation and nourishment, growth, excretion, secretion, energy and motion, reproduction or multiplication. At the bottom of the various evidences of cellular function is *cellular metabolism.* This consists in the performance of certain chemical changes in the interior of the cell, brought to bear on the food matter brought to the cell, as a result of which the cell is enabled to add substance to itself (assimilation, growth). Besides this use of nutritive material, it is also employed for the discharge of certain functions. Some of the *metabolites* (products of metabolism) are unfit for further use, and are cast off entirely (*excretion*); others are discharged from the cell for use elsewhere in the economy (*secretion*).

Further, the production of *force* or *energy* depends upon the same intra-cellular changes, as in the production of nerve force. These expressions of energy take various forms of manifestations, as the production of motion, etc.

Cellular Motion is of several kinds: *amœboid*, called so from the changes (like in the amœba) in the cellular shape, the motion being very slow and gradual; *ciliated* (or flagellate), called so from the motion being constant and in one direction only, given to the cilia of ciliated cells, the purpose of this motion being to sweep from the surface of the cell any matter deposited there. The muscle cells show *cellular contraction*, the combined contraction of the mass of cells being the cause of the apparent contraction of the body.

Multiplication of Cells is brought about in one of two ways: either by *direct* (amytosis) or by *indirect* (karyomytosis, karyokinesis) division. In either case the process consists of the division of the cell into two. In *amytosis* the division consists in an hour-glass constriction of the nucleus at its middle to the complete division of the nucleus into two, the division of the cell following upon this. In *karyokinesis* the division consists in a complicated series of changes in the nucleus. These changes consist in a rearrangement of the loops making up the chromatine along the *equatorial line*, the *equatorial space* becoming wider and wider as the process advances, until complete division takes place by the accompanying constriction of cell-body and nuclear body.

Three stages are recognized in the changes of these loops:

1. Thickening of the primary, disappearance of the secondary, filaments.
2. Longitudinal splitting of the filaments.
3. Rearrangement of the filaments.

(*a*) Monaster or Mother Star.

(*b*) Ampliaster, Double Star or Daughter Star.

Tissues must be specially prepared to show these changes in the mitome, and it is even more difficult to demonstrate changes taking place in the cell-body.

In the formation of tissues we speak of the essential (archiblastic) cells of the tissue or organ, as the *parenchymatous cells*. About these, and acting as a skeleton or framework for the tissues, are the *parablastic* or *connective-tissue cells*, existing both as the grosser *connective tissues* and as the delicate *intercellular substance*.

In the adult the connective tissues consist of *fixed* and *wandering* cells, the latter moving about among the archiblastic structures (red and white corpuscles, lymphoid cells).

Shapes of Cells. These may be of almost every conceivable variety, the most common being the following: Cylindrical or columnar, conical or pyramidal, spherical or polyhedral, ciliated, stellate and flat cells, which latter are either arranged in a single layer with the edges closely approximated—"tesselated"; or arranged in superimposed layers like the scales of a fish—"squamous."

Positions of Differently Shaped Cells. The flat or polyhedral are most frequently found lining the surface of membranes or tubes (ducts), while in the center of organs spherical or polyhedral cells (often called glandular cells, because making up the parenchyma of glandular organs) are found, their shape being due to pressure from surrounding tissues. Ciliated cells are modifications of columnar cells, having at one end a tuft of cilia or hair-like projections, which lash in one direction, carrying substances along, as in the bronchi and "Fallopian-tubes." Stellate cells are those so named because they have a number of ray-like projections passing in various directions from the cell-body.

CHAPTER II.

CLASSIFICATION OF DISEASE **(Nosography—Nosology).**

This is done in a necessarily unscientific manner, because of our ignorance of the processes concerned. There are numerous classes but none are satisfactory or complete.

1. *Alphabetic System*, in which diseases are arranged alphabetically, and of use only in dictionaries of medicine (as Quain's).

2. *Synoptic Method*, an arrangement of diseases according to certain very general characteristics, now obsolete, as no careful study of diseased states is made.

(*a*) Acute and Chronic.

(*b*) General and Local.

(*c*) External (applied to surgery), and Internal (applied to medicine). The latter (*c*) is used largely in Europe.

The above terms explain themselves.

3. *Symptomatic Method*, used to a certain extent, and based on symptoms, as fevers, dropsies, anæmia, hemorrhages, etc.

4. *Anatomical Classification*, depending on the parts of the body diseased, as skin, sexual, nervous or lung diseases.

5. *Mixed*, as the name indicates, is one in which all of the above are combined, and is largely employed to-day.

6. Again (*a*) *Functional Class* includes those diseases in which no demonstrable lesion exists, while the (*b*) *Organic Class* of diseases includes those in which a lesion is ascertained.

These latter terms (6) are used frequently in common parlance.

Latent (concealed or hidden) diseases are those (whether functional or organic) whose manifestations are not very apparent. The patient is ill, but no local conditions show themselves to make the disease diagnosable (as latent pleurisy or tuberculosis or malaria).

Local Diseases are those circumscribed to a part or an organ of the body.

General (*Constitutional*) *Diseases* involve the entire organism.

Extension of Local Disease. Local diseases may extend to neighboring organs or parts, or to distant organs or parts, and still be *local*, or, in the same way, may become *generalized*, producing general or constitutional diseases.

In what ways is this brought about?

1. By *Continuity*, the disease passing along a continuous struc- or tissue (thus a local peritonitis may become a general peritonitis).

2. By *Contiguity*, the disease passing from one structure to another (a pleurisy may thus produce a similar inflammation of the lung or pericardium).

3. A general extension of disease may occur through the *circulatory systems* (blood and lymph), and this is especially true of infec-

tious processes, their influence being generalized by entrance of micro-organisms or by bacteriological products, as ptomaines, toxines, etc.

When the specific cause (the micro-organisms) is carried in the circulation to distant parts to set up the same process there as in the original diseased focus, the term *metastasis* is employed, the term being generally used to signify this transference of disease, from any cause.

4. Local diseases also become generalized by an action of the nervous system, termed *reflex action*, examples of which are in the general nervous states brought about by local irritation of the genital apparatus; also, in infectious diseases generalized symptoms are frequently the result of nervous influence, as in the production of fever.

DIVISIONS OF CONSTITUTIONAL DISEASES.

1. Dyscrasiæ, when the most prominent of the general disturbance, is a lesion of the blood (as to number and shapes of corpuscles, or to changes in relations of other fluid constituents). Examples: anæmias, malaria.

2. Infectious Diseases are those general diseases brought about by the introduction into the organism of some living micro-organism. Examples: cholera and the acute fevers, as scarlet fever, measles, etc.

3. Intoxications are those general diseases produced by the actions of poisons introduced into the organism from the outside or elaborated in the body. Examples of this class are brought about by the animal and vegetable alkaloids (ptomaines, strychnia), or by the metallic poisons, as arsenic.

4. Unclassified Diseases, in which, along with the general disturbance, there is a marked tendency to localization to certain groups of tissues, as in rheumatism, arterio-capillary fibrosis and certain dermal affections.

MORBID PHYSIOLOGY.

Further study of disease demands further study of the *physiology of disease.*

Morbid Physiology may be divided into:

1. *Experimental Pathology*, the study of induced disease, usually in the lower animals. This branch has recently received much advance by bacteriological study.

2. *Symptomatology*, which refers to symptoms or disturbances of function in disease.

Under Symptomatology we study :

(*a*) *Diagnosis*, that branch of symptomatology which includes the rules which guide us in the application of our knowledge of the symptoms to the determination of the seat and nature of disease.

(*b*) *Prognosis*, or that branch of symptomatology according to whose laws the course, duration and termination of a disease may be foretold.

Symptoms (which are the apparent manifestations of altered functions of disease) are dealt with in forming a diagnosis, and may be broadly divided into :

(*a*) *Objective*, those discoverable by the explorer (as physician) by his *senses*, or by special means of investigation (instruments of precision), as yellow skin, black spots, etc.

(*b*) *Subjective*, manifest to the patient only as pain. The study of a group of these *objective symptoms* is called *Physical Diagnosis*, and constitutes an art by itself of applying the special senses *touch*, *sight* and *hearing*, to purposes of diagnosis ; hence physical signs are elicited by :

1. *Palpation*, where the touch aids us, as in determining size of an abdominal tumor, and eliciting *tactile fremitus* in chest diseases, etc.

2. *Inspection*, where the sight is employed, as in noting the conformity of chest in disease.

3. *Anscultation,* a valuable method, the organ of hearing being brought into use. Again the latter is subdivided into *three* groups :

(*a*) Anscultation proper, ear being directly used by the *mediate* or *immediate* methods.

(*b*) Percussion, where a series of strikings, as on the chest, produce valuable signs, as dullness, etc.

(*c*) Succussion, where shaking is employed to the determination of existence of fluid, as in abdominal cavity (ascites).

Another term in connection with symptoms is "*Pathognomonic Symptoms*," which are certain symptoms especially characteristic of a certain disease, as the *crepitant rale* of pneumonia.

Certain symptoms being present, the absence of some one disease may confidently be stated, and such symptoms are spoken of as "*Non-Pathognomonic*." For purposes of diagnosis, then, we must consider (1) objective examination of the patient to elicit objective symptoms and (2) *anamnesis*, the history of the case, which includes the relation of subjective symptoms.

Diagnosis may be either:

1. *Topographical*, the determination of the localization of the disease, to which branch the term Physical Diagnosis is applied.

2. *Nosological*, the determination of the nature of disease (pneumonia). A complete diagnosis demands both of these elements.

Prognosis has to with *duration*, *course* and *termination* of disease. From a prognostic point of view disease may be (*a*) *mild*, when a complete cure may be expected; (*b*) *severe*, when permanent injury or death is threatened. A disease is spoken of as (*a*) *ephemeral* or *benign* where a favorable issue within a short time is expected; or (*b*) *malignant* where in the course unforeseen complications may occur (as in scarlet fever); or to a disease whose termination is almost surely fatal. Prognosis may be (1) *favorable* where the termination of disease occurs without structural change or death; and (2) *unfavorable* where injury to tissue or organs or death of the individual marks the termination of disease.

Duration of Disease. From this point of view diseases are spoken of as (*a*) *acute* when the duration is short and the disease shows a tendency to run a definite course terminated by recovery or death; (*b*) *chronic* when of a prolonged *duration* and irregular *course;* while midway between the above two stands (*c*) *subacute* (neither acute or chronic), and usually of less severity than is expected in acute forms, but of longer duration; (*d*) *blasting* or *fulminating* is one of exceeding brevity and usually terminating in death, as frequently seen in yellow and typhus fevers, cholera, pneumonia, etc. The majority of *acute* diseases have a definite duration, as pneumonia, 7 days, typhus, 2 weeks, and typhoid, 3 weeks.

Course (development and progress of disease).

1. *Regular* or *definite* course is one marked by regularity in its stages, and is seen in acute, never in chronic, diseases.

2. *Irregular* course shows no distinctness or regularity in its stages, and is common in chronic diseases.

3. *Periodicity* or *periodic* course is marked by the *special* manifestations of symptoms at certain regular periods of time. It is seen to a certain extent in acute diseases (in the morning and evening variations), but is typified by the manifestations of malaria.

The *stages* of a *regular* course are:

(*a*) *Infection*, the moment of entrance of the cause (micro-organisms) of the disease into the organism.

(*b*) *Incubation*, the period extending from infection to the first manifestations of the symptoms.

(*c*) *Prodromes*, the period of indefinite symptoms (first evidence of the disturbance, but not characteristic of any disease).

(*d*) *Invasion*, the appearance of characteristic symptoms; and it may be *sudden* or *frank* when there is a rapid change in the condition of the patient, or *slow* or *insidious* when coming on gradually.

(*e*) *Fastigium* (stadium, acme), the period of highest development of characteristic symptoms and of little variation. The fastigium duration is generally in proportion to duration of the invasion; thus, long in a disease of insidious onset, and *vice versa*.

(*f*) *Amphibolic stage*, which may be of very short duration, in which there occurs a disturbance of the symptoms indicating a change in the course.

(*g*) *Decline*, which may be *gradual* (*lysis*) or *sudden* (*crisis*). Diseases in which invasion is slow generally terminate by lysis, and vice versa.

Critical days are those in which a crisis is apt to occur in disease.

Critical discharges are those sudden and excessive discharges that often accompany the crisis in disease, as profuse sweating.

(*h*) *Convalescence*, a period after the subsidence of the disease in which reparative processes predominate, and terminating in recovery, health.

There may occur in the course of a disease:

Remissions: periods of decline in the severity of the symptoms.

Exacerbations: periods of increase in the severity of the symptoms.

Intermissions: periods of total absence of symptoms.

Paroxysms: periods alternating usually with intermissions, marked by the presence of all the symptoms in their severity.

Types of Disease (by which is meant the character a disease takes from the order in which the symptoms follow one another). Examples:

Continued Diseases, in which there occur no inter- or remissions (not absolutely, but when but slight variations occur in the intensity of the symptoms).

Intermittent Diseases, in which there is a period of no symptoms (apyrexia), alternating with paroxysms of intensity of symptoms (pyrexia), as in malaria.

Remittent Diseases, those marked by a tendency to alternation of periods of intensity of symptoms, with periods of milder symptoms.

Recurrent Diseases, which follow a course (often continuous) for several days, then an intermission takes place, in a few days again a period of fever, as in relapsing fever.

Terms used in regard to fever are: *Apyrexia*, when no fever exists; *pyrexia*, which means a temperature slightly above normal (100° to 102° or 103° F.), and *hyperpyrexia*, when the temperature of the body is 106° F. or over; *defervescence*, falling of temperature.

Termination of Disease is either in *recovery* or *death.* During convalescence a *relapse* (which is a second attack of the same disease, usually of milder and shorter duration) may take place. This must not be confounded with the *recurrent type*, for in the intermission of this latter the disease still exists in full force, though there are no outward manifestations. *Sequelæ* are diseased states engrafted during convalescence of a previous disease, as chronic inflammations of mucous membranes after measles or paralysis following diphtheria.

Death is the total cessation of the manifestations of life. It is either *sudden* or *fulminating* (the cause being either arrest of circulation, arrest of respiration, or central nervous disturbance, or *slow* when there occurs, preceding death, a *death agony* or *agonic period*, marked by a general paralysis of the functions of the organisms. The recognized modes of death are:

(*a*) *Failure of Circulation.* The death may be *sudden* or *slow.* If sudden, it is from one of two forms—(1) *syncope*, where there is arrest of the heart's action from disease of its walls or from nervous (reflex) inhibition of its action; or (2) *collapse* or *shock*, where there is a disturbance of the circulation from vascular changes (as by trauma or rapid dilatation of the vascular walls from paralysis of the coats, as in the case of a blow upon the abdomen. If this mode of death occur slowly it is called *asthenia.* It is the most frequent form of death, and large clots are apt to form in the heart, finally causing the circulation to cease.

(*b*) *Failure of Respiration*, called *asphyxia*, and may be caused by (1) disease of the respiratory structures (as of the air vesicles in pneumonia); or (2) by disease of the blood, failure of oxygenation, as in C. O. poisoning; or (3) by impediments to the entrance of air into the lungs, as by hanging, etc.

(*c*) *Death from Disturbance of Nervous Centers* is usually spoken of as death by *coma.* It occurs by operation of nervous centers, either on the *circulation* or the *respiration*, bringing about failure of one of those functions. With either of these two there generally occurs disturbances of the mental centers, as of consciousness, hence the name *coma*.

Apparent Death. There is a condition closely simulating true death, called *apparent death*. It is a condition in which mistakes may be made and living burials made possible. Apparent death may occur in coma of epilepsy, in catalepsy, hysterical "trances," and in exhaustion after great efforts; especially in *cholera*, shock and hemorrhage, drunkenness, hanging, lightning or heat strokes, poisoning from coal gas, and narcotic poisons. As a means of diagnosis it is important to know the **Signs of True Death:**

1. *Arrest of Respiration.* Movements of the chest are to be looked for. A slight motion may be detected by noticing waves passing over water in a glass placed on the chest, or noticing moisture collect on a cold mirror held before the mouth, or the motions of a feather when held over the mouth caused by the respiratory wave. Best of all is *anscultation*, as the ear should detect breath sounds if the function is still preserved.

2. *Arrest of Circulation.* Here again rely upon anscultation to detect cardiac beats; or the pulse may perhaps be faintly felt. If the circulation has not entirely ceased, ligating a limb will produce a blue discoloration due to venous stasis. Again, irritants applied to the surface will produce redness or even blisters if circulation of blood exists, or a cut vein or artery will flow blood if life persists.

3. *Fall of the Body Temperature*, which depends on the temperature of the surrounding media, and does not fall below this. Practically one degree of heat is lost for every hour after death, robust persons and those dying suddenly cooling rather more slowly. The living body (normal temperature 98° F.) cannot fall below 70° F. In *cholera* and *tetanus* the temperature may rise from an hour to two hours after death.

4. *Cadaveric Lividity* (cyanosis or staining of the dependent portions of the body) is due to the leaking out of the vessels of the blood-coloring matter. None of the blood corpuscles, however, have escaped from the vessels, and no swelling exists, as occurs in a bruise. The blood can be pressed out of the part (not so in extravasations of a bruise, which latter may occur in any portion of the body). But when the fluids of the blood, impregnated with the coloring matter of *cadaveric lividity*, are thoroughly infiltrated into the tissues, pressure will not move the stain.

5. *Cadaveric Rigidity* (rigor mortis) is a condition of rigidity after death due to stiffening of the muscles, brought about by coagulation of myoscin. It must not be mistaken for a simple contraction of the muscles. It is usually first seen in the muscles of the jaw, neck, face, and then passing over the muscular system generally, while the time of its appearance varies with the individual and in various causes of death. As a rule, *rigor mortis* comes on *late*, and is of *long* duration in robust individuals and in those dead of comparatively acute diseases; and comes on *early* and is of *short* duration in non-vigorous people or those dying of prolonged exhaustion. An apparent exception to the first part of this statement exists in cases of persons dying very suddenly, and where, at the time of death, conditions of great exertion are present, as in those dying in battle, from strychnine poisoning, and sometimes in case of death by lightning. Rigor mortis is never delayed over twenty-four hours, but lasts two or three days, and even a week in some instances.

6. *Putrefaction*, which is the most positive sign of death; but its occurrence is delayed, hence its value as an early sign of death is *nil*, but in a very doubtful case it is best to wait until this sets in. It manifests itself as greenish spots, first seen upon the abdomen, from thence spreading; and is due to invasion of the body by bacteria, the soft parts being invaded first, fibrous tissue, the uterus and bones being the last to decompose. Rapidity with which putrefaction sets in depends upon several conditions, and occurs (1) most rapidly in a warm, moist atmosphere (less so in cool, dry air); (2) still less rapidly in water; and (3) most slowly in earth. The micro-organisms acting to production of this change are called *saprophytes*. A peculiar change of the body is seen in certain earths, converting it into a soap, which is known as *adipocere*, made of fatty acids of decomposing tissues, combined with magnesium salts or other alkaline earths.

7. *Contraction of the Muscle System* is seen at the time of (and not to be mistaken for) rigor mortis, and, other things being equal, goes on evenly in the flexors and the extensors; but because of the greater bulk and strength of the flexors they overpower the extensors, hence the legs are found flexed and drawn inwards, the arms flexed and fingers closed.

8. *Relaxation of the Sphincter Muscles* occurs at the time of death, the mouth dropping open, the sphincter-ani relaxing and permitting the escape of gas or fecal matter. Dribbling of urine takes place for the same reason.

9. *Electrical Reactions of the Muscles* is lost after death. Sometimes it is lost quite soon, at other times may persist for three hours after life is gone.

10. *Dilatation of the Pupils* is one of the most reliable of the *early* signs of death. Further eye changes occur, the glazing of the cornea and still later the sinking in of same. When the pupil contracts, as in some cases of *apparent death*, mydriatics will dilate, while if the pupil is dilated a myotic acts the opposite.

11. *Other Changes.* In apparent death the eyes are apt to be turned upward, while in true death there is fixed stare forward, and on opthalmoscopic examination the color of fundus looks leaden-hued, the appearance of the papilla lost.

CHAPTER III.

ÆTIOLOGY.

That branch of **Pathology** which treats of the cause and origin of disease. It is divided into (*a*) *External*, or those causes introduced into the organism from without, as the pneumococcus, producing pneumonia; *Internal*, causes originating in the body, as the cause of heart disease following upon Bright's. Most diseases (if not all) may be referred to external as the primary cause. (*b*) *Local causes*, or those acting only on one tissue or organ, producing local disease; *general causes* are those acting on the entire organism, producing general disease. (*c*) *Predisposing* (or remote) causes, or those preparing the individual favorably for the development of disease, and *exciting* (determining or immediate) those directly bringing about the development of disease.

Predisposing Causes are divided into: 1. *General*, those acting at the same time upon large masses of population; 2. *Special* (or *Individual*), those acting on one individual at a time, predisposing him to disease. Acting as **General Predisposing Causes** we have: 1. *Meteorological conditions*, among which may be mentioned temperature of air, humidity, winds and their directions, barometric pressure, electrical conditions of the atmosphere, and the presence of ozone. Taken as a class, no disease can be clearly laid to these causes directly, the action on the growth, reproduction and carrying (as by winds) of the germs being the manner in which their influence is exerted. 2. *Sunlight*, the exact manner of influence of which is uncertain, but that there is such influence is shown by the pallor and anæmia seen in those habitually away from the sunlight, as in mines. It is possible, too, that this operates upon the development of the micro-organismal cause of disease. 3. *Seasons*, which in various ways act upon micro-organisms. They also have some influence upon other forms of disease, as the inflammations of the air passages in winter; and, depending upon the various conditions presented by different seasons, certain diseases are especially prone to develop at certain times of the year, as pneumonia in winter and spring; typhoid fever in autumn and spring; malarial fevers in the fall and spring; yellow fellow in summer; small-pox in winter, etc. 4. *Climate*, which acts much as the seasons, and depends in general upon the average condition of the atmosphere and the soil. The influence is limited almost exclusively to the growth and development of micro-organismal causes of morbid states. For example, certain germs grow only in certain climates, or if are transferred to others will not live except during a season resembling the original climate. 5. *Soil*, which again predisposes through its influence on germs, the amount of *soil moisture* also acting, as in diseases like typhoid and cholera, which occur at seasons of little moisture. 6. *Moral impressions*, which usually act as *individual predisposing causes*, but occasionally there occur instances of such influences acting generally, as in the many cases of insanity during the "French Revolution," or in the hysterical cases that arise at times of religious revivals.

Individual (or Special) Predisposing Causes are those acting upon the individual: 1. *Age* acts both upon the *morbility* and *mortality* of the individual. The majority of diseases characteristic of the different ages are micro-organismal, and the influence of age to a great extent depends upon the fact that this or that age offers tissues especially favorable to the action of this or that germ; or again these differences depend upon differences in the degree of exposure permitted by this or that age. Many of the eruptive fevers occur in the young, they having tissues more favorable to the growth of micro-organisms; or it may be assumed that these diseases occur at this period simply because children are unprotected against their influence, adults being protected largely by having had a previous attack. Measles will attack young and old alike in a community where this disease has not been epidemic for some time. Among the diseases of *childhood* may be mentioned scarlet fever, lobular pneumonia, tubercular meningitis, tetanus neonatorum, whooping cough, and various inflammations of the gastro-intestinal tract, of catarrhal and follicular varieties; also diphtheria, rickets (a disease of development of bone), and among nervous diseases hydrocephalus and chorea.

Among the diseases of *adults* are those due to exposure, etc., as typhoid fever, lobar pneumonia, syphilis, malaria, rheumatism, gout, chlorosis and other forms of anæmia; diseases (inflammatory) of the parablastic (connective) tissues, with especial tendency to chronic induration and to cancer, which, along with *gout*, are apt to occur late in adult life.

In *old age*, when body changes are retrograde in character, various catarrhal affections, especially of the respiratory tract, are met with; also a tendency to fatty degeneration, especially of circulatory apparatus, giving rise to apoplexies, paralyses, etc.

2. *Sex* influences the occurrence of disease, partly through *peculiarities of the sexual apparatus*, and partly through the *manner of life* of the two sexes, the male being usually more exposed and active in his occupations, the female more sheltered and sedentary. For example, yellow fever is especially apt to occur in males; according to statistics, the disease being prone to attack persons coming into the tropics from cooler climates, such persons usually being males. One disease, however, *whooping cough*, without any of the above considerations, seems to have a special predilection for and with more serious consequences in the female than in the male. There are certain diseases of the nervous system which seem to be particularly associated with disturbances of the female sexual organs—hysteria and chlorosis.

3. *Race* seems to have an influence upon a certain few diseases, not marked except as to the severity of the manifestations of the disease, as shown by the severity of measles in negroes. Differences in morbility and mortality in various races are in a great degree dependent upon social conditions (as cleanliness) and upon the character of the climate in which the race originally dwelt, as shown by negroes in the United States (Southern States) having a tendency to tuberculosis from their unhygienic surroundings and being in a different climate from the original (Africa). Again, the colored race *seem* especially immune from yellow fever and gonorrhœa with its

consequent complications and sequelae (strictures, etc.); but even this apparent fact is doubted, for these diseases may exist in colored people frequently, but of such mild types as to be overlooked.

4. *Temperament* is the peculiar manner of being brought about by habitual slight disturbances (within physiological limits) of one or the other of the important functions of the body. Should such disturbances of functions pass beyond physiological bounds, it of course constitutes disease. The following temperaments have been described: (*a*) *Nervous*, in which the function of the nervous system is important. (*Heredity* has more to do, however, in the causation of nervous diseases than nervous temperament.) (*b*) *Sanguineous* temperament, in which there is a tendency to plethora. (*c*) *Bilious*, in which the gastro-intestinal system is important. Some have proposed, instead of the above, the *acid* and the *alkaline*, based on the idea that the tissues and fluids of this or that individual are either acid or alkaline in reaction, thus favorable to this or that micro-organism.

5. *Constitution*, by which is meant the resistive power of the individual to morbific influences in general. We have the *strong* and *weak*.

6. *Idiosyncrasy*, which is the resistive power of the individual toward *particular* morbific influences; *e. g.*, some persons are especially liable to take measles, having the disease in marked intensity, even in mild epidemics; or, again, this disease is inapt to be taken by some individuals, while typhoid fever may be taken several times by some, when but one attack is usual. Such idiosyncrasy may also be seen in relation to certain drugs. *Immunity* is a certain form of idiosyncrasy, and means that an individual cannot contract a certain disease. The theories as to this will be given later.

7. *Habits*, which influence is probably generally a question of exposure of the individual to special causes of disease, the so-called "hereditary insanity" being cases, probably, of insanity depending upon faulty habits acquired in bad education, poor training, etc., received from an ill-balanced parent.

8. *Profession*, which is operative simply through the exposure of the individual to the causes of disease; *e. g.*, the physician is brought in contact with many diseased persons, and is therefore liable to attacks of such diseases; so, too, he is exposed to many and sudden changes of temperature.

9. *Alimentation*. By this manner of infection many of the special

causes of disease are introduced into the system. The intestinal and a number of other animal parasites are probably taken into the system in this manner.

10. *Inanition* (malnutrition), which condition must predispose to various forms of anæmia and to wasting of the tissues, and often acts as an *exciting* cause as well. It is a factor in the cause of scurvy and rickets.

11. *Exercise.* Excessive exercise may develop certain cardiac affections, as is seen in connection with excessive marching efforts of troops in time of war. Hernia may also be the result of great effort. Diminished exercise is apt to give rise to obesity (excessive deposit of fat), to imperfect elimination from the body of certain products that should be thrown off, and in this manner causing uric acid diathesis.

12. *Continence and Celibacy.* It is difficult to say to what disturbances celibacy exposes one, but there is no doubt but that it is a factor in causing increase in mortality. It probaby exercises a certain amount of influence through the fact that those who practice continence and celibacy expose themselves to a greater degree and more readily than do those who have families depending upon them.

13. *Dress and Bedding.* The influence of these is obvious, as exposure to wet and cold from poor clothing, etc. The *dwelling* also is influential in production of disease, a damp abode predisposing to rheumatism, etc.

14. *Hereditary Influence.* Of this we have the *true* and *false*, the latter meaning the transmission of the predisposition to disease because of the offspring being exposed to the same influences as the parent. This is especially so in *tuberculosis*, the child being born free from the disease, but in a short time contracts the disease by his mode of life, which resembles the parents'. The disease *pellagra*, among Italian peasants, and certain cases of insanity, are both examples of false heredity. True heredity is where the disease is directly inherited, and may be of the *trophic* or *infectious* varieties.

Trophic Heredity. It is well known that there is a *physiological heredity*, and upon the existence of such depends the argument for *pathological transmission ;* all depending on the same trophic (nutritive) influence of mother cells being transmitted to the daughter cells, as in unicellular organisms. In this form of inheritance, then, there occurs a *direct* modification of the process of development after the coming together of the sperm and the ovum; and thus the offspring has the tendency to same diseases as the parent. Sometimes one generation is skipped, and the disease sometimes limited to certain branches of the offspring, as in the case of **Hæmophilia.** This disease is usually transmitted only through the females, the male offspring of a case of hæmophilia (bleeders disease), though affected, rarely transmitting it to the children propagated by himself. *Nervous diseases* are often examples of trophic heredity, as is *gout*, *arterial degenerations*, *etc.*

Infectious Heredity. Here there occurs a direct transmission of the micro-organismal cause of the disease from the parents to the children, an actual inoculation from mother or father to the fœtus; examples, syphilis and tuberculosis. If the transmission is from the *mother* the micro-organismal cause is passed through to the fœtal circulation from the placental circulation. This actually happens, as has been proven experimentally in a number of the acute infectious diseases. If the transmission is from the *father* to the child only, it is due to germs carried by semen remaining latent after *primary* coitus, or to the inoculation of the placenta during *subsequent* coitions.

Determining Causes. Those which directly bring about the development of disease. They are also termed *exciting*, *proximate* or *immediate* causes, and may also be classed as **General Determining,** those acting to production of disease in large numbers of people, and **Individual Determining** causes, those immediately bringing about disease in a single individual.

Among *determining causes* may be mentioned: 1. *Moral impressions*, which seem to act through the nervous system, as in chorea, insanity. 2. *Poisons*, both mineral and vegetable, producing by their own properties decided alterations in structure and function, as action of some minerals on the gastric mucous membrane. 3. Many *predisposing causes* may act so by special circumstances, as electricity in form of lightning, or temperature as in "catching cold," the latter being brought about in one of several ways: (*a*) by checking perspiration, and thus retaining effete and noxious products in the body; (*b*) by acting on peripheral nerves and reflexly producing disturbances of circulation; or (*c*) the cold may produce some alteration in the secretions, making a favorable field for growth of micro-organisms, as is attested by the epidemic character of certain diseases attributed to catching cold; (4.) *living organisms* (many micro-organisms), which, when introduced into the body, produce special disease symptoms.

Diseases thus produced are called *infectious* and *parasitic*, the latter term really including them all, as any organism living on another is a parasite. *Infectious diseases* are those general diseases caused by *unicellular* organisms (rarely is local disease produced by them), while *parasitic diseases* are caused by multicellular organisms (animal or vegetable), and are generally local diseases; exceptionally, a general disease being caused by them.

A *classification of organisms* may also be made according to the location of their disease production; those causing disease on the surface are Epizoa) if animal) or Epiphytes (if vegeable); those acting interiorly are Endozoa (animal) and Endophytes (vegetable).

Among *animal organisms* producing disease we have the (1) Protozoa, unicellelar, and low in the scale of life, as the Rhizopods, Infusoria and Sporozoa; (2) Vermes (worms, flukes, etc.); (3) Arthropodia, animals with segmented bodies and having limbs, as ticks, fleas, mites, lice, etc.

Among *vegetable parasites* occur (1) Schizomycetes (bacteria, cleft-fungi, so called because they multiply by cell-division); (2) Saccharomycetes (yeasts, yiest-fungi, sugar-fungi, dust-fungi); (3) Hyphomycetes (filamentous fungi, moulds).

Actinomyces, the organism causing "swelled jaw" in cattle, is a vegetable organism as yet unclassified.

Results of Introduction of Living Organisms into the System. These are either *local* or *general*. The local disturbances are of inflammatory nature, caused by mechanical irritations arising from the presence or activities of the organisms; these inflammatory changes are accompanied by proliferation of cells and new tissue formation. The general disturbances are of several possible varieties, depending on the mode of origin: (*a*) The organisms introduced into the system may induce general nutritive disturbances (as intestinal worms, preventing proper digestion, thus causing symptoms of disease, as diarrhœa), or in a more complicated manner by abstracting oxygen which is necessary for the nutrition of the body; (*b*) they may cause innumerable foci of local inflammation, thus producing general disturbance; (*c*) by their activities of growth, reproduction, nutrition, etc., they may give rise to poisonous materials (ptomaines), which, being absorbed, act on the whole system as any general poison.

Infectious Diseases. The organisms specially concerned in the production of these are the Schizomycetes or bacteria. There are two varieties of *infectious diseases:*

1. *Miasmatic Diseases*, or those infectious diseases which are produced by micro-organismal causes arising from outside the animal body (from soil, water, etc.). The poison is called a *miasm*. Example: malaria.

2. *Contagious Diseases*, or such infectious diseases as are produced by micro-organisms derived from another individual (either living or dead, human or lower animal). The virus is called *contagium* or contagion, the transmission of which cause of contagious diseases is not always directly from one individual to another; the poison being introduced by devious ways (the water, food, etc.): and to such diseases in which the transmission requires certain intermediate steps the term *contagio-miasmatic* has been applied, though the term finds little acceptation.

For practical purposes contagious diseases may be divided into five classes:

1. Those found *only* in man originally, and transmissible to the lower animals, as scarlet fever, measles, syphilis and gonorrhœa.
2. Those requiring for their distribution certain general *telluric* or *atmospheric* predisposing conditions—sweating fever, influenza, dengue, cerebro-spinal meningitis, typhus and relapsing fevers.
3. Certain contagious diseases occurring *chiefly* in man, but inoculable to lower animals, as tuberculosis, pyæmia, septicæmia erysipelas, and diphtheria.
4. Those originally occurring in the lower animals and transmissible to man, as glanders, anthrax, hydrophobia, etc.
5. Those requiring special conditions of the medium of transportation, as typhoid fever, cholera, yellow fever and dysentery (these being *contagio-miasmatic*).

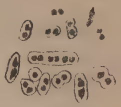
CHAPTER IV.

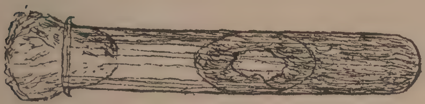
Schizomycetes (Bacteria, Cleft-Fungi).

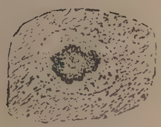
The characteristic feature of these micro-organisms is their method of reproduction—by cell-division. Those bacteria which always retain the same shape are called *oligomorphous*, of which the following classes occur :

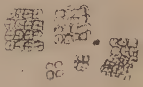
1. Cocci. Small round or oval organisms, which are further divided, according to their method of growth, into :

(*a*) *Diplococcus*, where the cocci occur in pairs, as in diplococcus pneumonia. (*b*) *Streptococcus*, the cocci growing in chains (the individual cocci are usually less than 1 u. or micromillimeter (1-25000 in.) in diameter, as streptococcus erysipelatis. (*c*) *Micrococcus*, the individuals occurring singly or in irregular groups, as the micrococcus of suppuration, commonly called staphylococcus because the macroscopic appearance of the growth resembles a bunch of grapes. (*d*) *Merismopedia*, those occurring only on the surface of the culture media. (*e*) *Sarcina*, those occurring in fours, sixs, eights, etc., growing in all directions. (*f*) *Ascococcus*, those contained in a utricle made up of colloid matter.

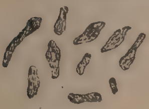

Diplococcus.

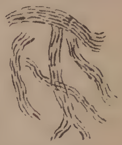

Staphylococcus.


Ascococcus.

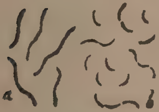

Sarcina.

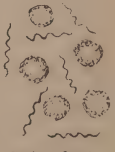
2. Rod-like Micro-organisms—Bacilli. These may arrange themselves in the same forms as do the cocci as merismopedia, etc. They may also be classified, from their shapes, as the *leptothrix*, growing in chains, or the *claustridium*, growing in club shape.


Claustridium.


Leptothrix.

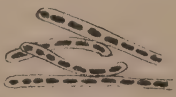
3. Spirilla (spiral bacteria, those rod-shaped bacteria arranging themselves as spirals, either one or several constituting the spiral: (*a*) *Spirillum*, not a complete spiral, simply a double curve ; (*b*) *Vibria*, less of a spiral than the above, simply a spiral ; (*c*) *Spirochæta*, forming a real spiral.


Spirillum.


Spirochæta.

Those organisms which vary or change their forms, depending on conditions of growth, are known as *pleomorphous* micro-organisms:

1. *Cladothrix*, characterized by an apparent, not a true, branching.

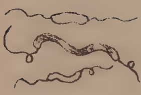

Cladothrix.

2. *Beggiotoa*, characterized by their filamentous crossing ; the filaments (really leptothrix) are obscured

by marked granulations which are really sulphur. In masses they cause large slimy growths, which often block up waste pipes, etc.

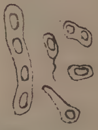
3. *Crenothrix*, really bacilli enclosed in a gelatinous cylindroid.

Properties of Micro-organisms.



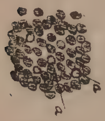
Flagellæ.

1. *Motility*. Some show considerable motion, which is either an oscillating one, especially seen in the larger forms, as in beggiotoa, or else a more rapid motion produced by flagellæ, only seen when the organism is at rest.



Endogenous sporulation.

2. *Reproduction*. As is shown in the various species, multiplication may take place in all directions, the masses thus resulting being called *zooglea*. As a rule, reproduction occurs by cell-division. Another method is by *sporulation* (formation of spores). The spores or seeds may be either *endogenous*, formed within the adult bacterium, extruded and developing into another adult bacterium; or *arthrogenous*. This latter form occurs especially among the cocci. A mass of cocci may be found growing in the usual way (cell-division), and in the mass some of the individuals seem different from the rest, being more shining and refusing to stain readily, and these are probably real spores, evidently of different structure from the surrounding individuals; which makes them more resistant to reagents, heat or cold, than adults. The name "arthrogenous" is derived from the Greek, and means a member (of a colony).



Arthrogenous sporulation. (*a*) Arthrospores.

3. *Nutrition*. Bacteria are also known as a division of *Protophytes*, as are also the *Algæ*, which latter have no connection with disease and contain chlorophyl, the coloring matter of plants, which enables them to obtain nutrition from the inorganic world. Bacteria and fungi, being devoid of chlorophyl, depend upon organic material, as animals do. In artificial cultivation of these plants they may obtain the *carbon* necessary for their sustenance from various substances, as sugar, glycerine, citric acid. *Nitrogen* is supplied by the albuminoids (being first converted into peptones by the fermenting power of the bacteria), or it may be derived from the salts of NH_3 and other nitrogenous compounds.

From their reaction to oxygen these bacteria may be further classified. Some grow readily in a full supply of oxygen, and are called *aerobic*, and removal of oxygen retards their growth. Others grow only in the absence of oxygen, away from the air, and are called *obligatory anaerobic* (oxygen retards their growth). Between these two forms another variety exists, called *faculative anaerobic*, growing both in and away from air. The micro-organisms causing infectious diseases belong to one or other of the last two classes.

These micro-organisms may grow in the *living* or in the *dead* body, acting as *parasites* in the former instance, while those growing in the cadaver are called *saprophytes.*

Pleomorphism. While change of form does exist in some pathogenic organisms (but not so frequently as in non-pathogenic organisms), yet the theory of some observers that all micro-organisms are really a single one, which under changed conditions presents various characteristics and appearances, is not upheld, as each organism has a *specific* property of producing a *special* disease, which change of form cannot alter (tubercle bacilli could never produce Asiatic cholera).

Interference of Growth of Micro-organisms.

1. *Change of temperature* affects the growth quite differently according to the amount of heat applied. A too high or too low temperature arrests their growth. A temperature of 60° F. will retard the growth of most and kill some varieties. Spores resist all influences much more than do the bacteria proper. In liquids the temperature of boiling water will kill all bacteria, but is not sure to destroy all the spores, a temperature of 105° C. or more being required to kill all spores. Dry heating demands a much higher temperature—at least 140° C. for three or four hours.

2. *Competition* with other forms of micro-organisms is an unfavorable factor to growth; the poisons (ptomaines) elaborated by some having become poisonous to other organisms excepting one (or finally all organisms may thus be destroyed). Planting equal quantities of cleft-fungi, moulds, and yeasts in some sugar solution, it will soon be found that only the bacteria are growing, causing a lactic acid fermentation perhaps; the yiests only would have developed if .5 per cent. solution of acetic acid had been added, producing their special alcoholic fermentation; while if a larger quantity of acetic acid (5 per cent.) had been added the moulds alone would have developed.

3. *The number of spores* or micro-organisms that have been

planted exercises considerable influence on their growth, as does *motion* of the media in which they are growing.

4. *Some Few Drugs.* *Antiseptics* are those drugs which merely arrest growth of organisms (*i. e.*, don't destroy the spores), while *disinfectants* or *germicides* actually destroy organisms and their spores. Examples of the former are mercuric-bichloride in solution 1 to 20,000, SO_2, carbolic acid in 1 per cent. solution, the essential oils, salicylic acid, quinine, thymol, and picric acid. Among disinfectants are $Hg\ Cl_2$, in solution 1 to 1,000; carbolic acid, 5 per cent. copper salts, as $Cu\ SO_4$; as is copperas, $Fe\ SO_4$, and generally salts containing chlorine and calcium. All antiseptics and disinfectants are more effective when dissolved in water, and the gases they produce also act better in a moist atmosphere.

Excess of nutrition also acts unfavorably when coupled with diminished proportion of moisture. Upon this fact is based the mode of preservation of meats and fruits—*i. e.*, by evaporating their moisture and compressing the nitrogenous materials.

Micro-organismal Products, or changes taking place in certain media of organismal growth :

1. *Fermentations*, which are produced by their growth in non-albuminous (non-nitrogenous) material, CO_2 being also given off.

Varieties. (*a*) *Alcoholic*, which occurs in vegetable infusions containing sugar.

(*b*) *Lactic acid*, in which sugar of milk is changed to lactic acid.

(*c*) *Acetic acid*, where acetic acid is produced.

(*d*) *Butyric Acid* fermentation may take place in milk, and sometimes in the stomach.

(*e*) One in the urine, by which urea is broken up, carbonate of ammonium being formed, which latter produces the odor of decomposing urine.

2. *Putrefaction* or *putrefactive fermentation* is one occurring in albuminous nitrogenous bodies, the following substances being formed : *peptones* (modified forms of albumen), certain animal alkaloids (ptomaines), the latter being very poisonous, destroying other organisms and producing symptoms of disease, as do the vegetable alkaloids; toxines or poisons not alkaloidal in character, bitter stuffs, coloring matter, phosphorescence, the final products being such compounds as H_2S, NH_3, CO_2 and H_2O, and in the terminology of the chemists this is called a process of hydration with reduction and oxidation.

Those organisms producing color are called "*Chromogenic*," while those producing disease are called "*Pathogenic*" micro-organisms.

Relation of Micro-organisms to Disease.

1. *Abundance.* They are found in the air, water, food, solids that surround us, etc., and the abundance is to an extent connected with density of population. In the depths of forests, on the high seas and on mountain tops, germs are fewest. Being so numerous, it is important to know "how they are kept out," and "how they get into the human body." They gain admission by breathing in drinking or eating the germs, or through abrasions in the skin Germs can be deposited from the air on solid or liquid media, but the opposite is probably impossible, except the solid or liquid have been dried into dust. Upon this question hinges the infective power of such media as sputum of consumption, stools of typhoid fever, etc. Organisms are kept out of the body by the fact that they may be destroyed by actual digestion, changes of temperature, or through the power of destruction possessed by certain cells of the body (phagocytes), the process being called *phagocytosis.* The epithelial cells especially resist the entrance of germs into the body.

2. *The Body as a Soil.* Certain forms of bacteria find the body an unfavorable soil for their growth, and upon inoculation produce no symptoms, as in case of micrococcus luteus. Other varieties, as the anthrax bacillus, if inoculated even in small quantities, may produce grave symptoms, depending on the individual as a soil for that particular bacteria. Bacteria exist normally in some of the cavities of the body, as stomach, intestines, air-passages; but are abnormally found in the air-vesicles and in the urinary tract.

3. *Method of Spread Through the Body.* (*a*) Among the cells of the *continuous* and *contiguous* structures. (*b*) Carried by lymphatic or hæmic circulations, causing a secondary diseased foci (metastasis), or producing a general disease.

4. *Effects of Micro-organisms within the Body.* (*a*) They may produce certain alkaloidal substances—*ptomaines*, the absorption of which brings about various symptoms of poisoning in the infected individual. The composition and physiological action of a number of these ptomaines are well known, as they have been isolated and experimented with, resembling to a certain degree vegetable alkaloids, as atropia and morphia. (*b*) By mechanical irritation they may produce

changes, usually degenerative in character, as fatty degeneration, but sometimes proliferations of cells and inflammations are apt to result. (*c*) Certain bacteria produce certain specific effects, as syphilis—*gumma* being formed.

5. *Method of Disease Production by Pathogenic Micro-organisms.* There are several theories to account for this: (1) By the production of *ptomaines* given above; (2) by *local irritation* from innumerable foci setting up inflammations, etc.; (3) by abstracting oxygen required for the blood-corpuscles, or by other nutritive disturbances as produced by some organisms.

Immunity is the peculiarity of certain individuals (or species) by which certain diseases cannot be contracted, no matter how intense the exposure (as of measles or smallpox), and may be either (*a*) by having had the disease before; (*b*) by having had another disease, as confirmed by experimental inoculation with disease virus; (*c*) or it is not to be explained, the person, however, never taking the disease. Hence, we have several *theories of immunity:* (*a*) *Retention Hypothesis* supposes that by a previous micro-organismal activity (disease) in the body something has been formed which retards further growth of organisms in the system. There has never been demonstrated such a retained substance. (*b*) *Exhaustion Hypothesis*, the reverse of the above, by which it is meant that the organisms destroy some chemical substance in the body which was necessary to their development. (*c*) Phagocytic theory, by which it is supposed that the white blood-corpuscles destroy micro-organisms. (*d*) The best theory is that some chemical substance of the blood serum is destructive to micro-organisms in general, and may go on to immunity.

Prevention of Disease. The study of this subject of *immunity*, although yet without proper explanation, has led to most of the practical methods of modifying the severity and production of the phenomena of disease. Thus micro-organisms may be so modified that they become incapable of producing their ordinary manifestations in a healthy person, but instead produce an immunity against the disease. This modified virus, then, is known as *vaccine*, because such condition was first found in relation with smallpox in vaccination. This modification or *attenuation* of virus is accomplished (*a*) by passing the micro-organisms (by inoculation) through the body of an animal not very prone to that particular disease; (*b*) by cultivating the micro-organisms under conditions unfavorable to growth, or in the presence of substances acting as poisons to them, or by changing the temperature (especially elevating it) for periods of time, or by CO_2. Virus of *hydrophobia* is attenuated by carefully removing the spinal cord antiseptically, and hanging it in a chamber containing calcium chloride, to remove humidity. The chamber is then moderately heated (not enough to kill the germs), and thus the growth is accomplished in a dry, hot atmosphere, conditions in which the character of the virus is altered so as to produce an immunity from hydrophobia when the virus is inoculated (Pasteur).

Vaccination is a term applied to all artificial means to make man refractory or immune against a certain disease.

Specific Nature of Infectious Diseases. As a rule, they confer immunity after one attack, although some do not; as tuberculosis. Among those in which immunity is produced by inoculation of attenuated virus are anthrax, hydrophobia, tetanus (to a certain extent), diphtheria, œdema (emphysematous). Some diseases, on the contrary, have a particular predisposition to recur again and again, as cholera, relapsing fever, influenza and malaria. Even in these latter diseases we may say immunity exists for a short time, since they seldom recur in the same individual during the same epidemic.

Demonstration of Bacteria. We have certain methods of cultivating and studying bacteria, and for this purpose we resort to "microscopic technique" and "culture methods." A red blood-corpuscle can contain many of some micro-organisms (100 cocci, or 3 or 4 baccilli). Micro-organisms then, being so small, have to be stained to recognize them. All bacteria possess the property of taking up the the *basic* aniline stains to a greater or less degree, and after being stained may have the color discharged with greater or less facility by the acids and alkalies (*decolorizing and differentiating* agents). The addition of certain substances, as aniline oil or carbolic acid, to the basic anilines causes the dye to be carried into organisms even better, and hence makes the bacteria less sensitive to decolorizing agents. These substances are called *mordants* or fixing agents.

The basic aniline colors most frequently used are fuchsin, methyl and gentian violets, methyl blue, Bismark brown and safronin. For the purposes of staining these, reagents are made up in alcoholic and watery solutions, the former from 20 to 25 per cent., the watery from 2 to 5 per cent.

Some of the *decolorizing agents* are the strong mineral acids, as

HNO_3 and HCl, iodine and alcohol. Among *mordants* 5 per cent. solution of carbolic acid in water or a saturated watery solution of aniline oil are used.

An easy and rapid method of staining often used in trial examinations for bacteria is as follows: Spread the medium containing the organisms evenly and in a thin layer by rubbing it between two cover glasses. Dry this in air or by passing the cover glass (smeared side up) three times through the flame of a spirit lamp. This fixes the medium by coagulating the albumen in the preparation. Holding the cover glass (smeared side up) with the fingers or forceps, drop upon it a few drops of a watery solution of one of the above dyes from a pipette, and allow it to remain for a few moments. The excess of stain is then washed off by a gentle stream of water; or the stain may be placed in a watch glass and the prepared slide placed upon it (smeared side down) and allowed to remain for a few moments, then removed and washed as above. In either case, turn the moistened smeared side on a glass slide and make your examination. Above is for an immediate examination. If you wish a permanent preparation, drop a drop of Canada balsam on the slide, then place the cover glass on it, heat gently to spread it out and get rid of air bubbles.

Special Methods. Special methods of staining are used where differentiation is required, the mordants or aids to staining also being used. Among them we have Weigert's *Fibrin Stain* for micro-organisms, which is suitable for tissues and cover-glass preparations. The solutions used in this method are as follows:

No. I.

R. Aniline oil 1.
Alcohol 6.
Aq. sol. (5 per cent.) Gentian Violet 43.

No. II.

R. Sol. Potass. Iodide (5 per cent.)
Iodine to saturation.

No. III.

R. Aniline oil, - 2.
Xylol, - - - 3.

If a tissue section contain micro-organisms, the preparation may be made by slipping a glass slide under it.

Next: 1. Remove from water, dry with bibulous paper.

2. Drop stain No. 1 on it for ½ to 1 min. Dry.

3. Drop a few drops of No. 2. Dry.

4. Wash out excess of iodine with No. 3.

5. Clear in xylol and mount in balsam.

Cultivation of Micro-organisms. The artificial cultivation of micro-organisms is accomplished by furnishing them the conditions necessary for their growth; as nutrition, moisture, proper temperature, air, etc. One of the prime objects of cultivation is *isolation* of the various forms for the purpose of study, accomplished by repeated dilutions of the culture medium. For this purpose the ordinary solid media, as gelatine (fluid at higher temperatures, solid at lower), nutrient in character, is used. A tube containing this medium is inoculated from some source (as from a *potato culture* of the micro-organisms), and it is found that various forms of bacteria are developing. The problem is their isolation. A small part of each of the various colonies is removed by a sterilized platinum wire (held in a glass handle usually, often curled at the point and called an öse), and placed in fresh tubes of nutrient material. After this dilution has been carried on to a moderate degree in order to more easily separate the colonies of growth, the nutrient fluid containing the highest dilution is kept at body heat (as by keeping tubes in the vest-pocket, 36° C.) by warming it and then carefully poured over a sterilized glass surface (*plate culture*) in an aseptic atmosphere. The various micro-organisms, on account of the extent of surface over which the nutrient fluid has been spread, develop in *colonies*, which are usually isolated and separated from each other. Thus one may pick up comparatively pure cultivations upon the sterilized öse and inoculate them in new tubes, in this way obtaining *pure cultures* of the various forms. This dilution method has only been possible with such media as gelatine, etc.—the solid media—and the credit of their introduction is due to Koch. Prior to his methods the fluid media were generally used, as bouillon, simple meat extracts, etc. In cultivation special care should be paid to the temperature in which the cultures are kept, various forms requiring different temperatures, and many developing only within a very narrow range. The degree of temperature suitable to growth is often of service in diagnosis of the various forms.

Among the different media used for the cultivation of bacteria may be mentioned (all sterilized, of course): peptone-gelatine, peptone-agar-agar, inspisated blood serum, bouillon, boiled white of eggs, boiled potatoes, etc. *Potato cultures* are made by thoroughly washing the potato, then rinsing in an antiseptic solution. Now pare the potato with a sterilized knife, and cut a slice away from the center, on which inoculate the organisms by a sterilized wire and place in a dish (sterile). You can now put the potato into an *incubator*, and allow it to remain from twelve to twenty-four hours, when the microscopic appearance can be studied.

In preparing *gelatine plate cultures* the *test-tube cultures* containing the gelatine dissolved in beef broth (a good food for the bacteria), kept at about 36° C., is poured on plates of glass kept level over an ice chamber. These can be put in an oven to await cultures. The great advantage of gelatine is that it is transparent, and liquefies at the body temperature. Thus, in test tube cultures, by such liquefaction the organisms are widely diffused, aiding much in isolation and study of individual bacteria.

RESUME OF SCHIZOMYCETES.

(*a*) **Cocci.**

1. *Chromogenic Forms*, those producing peculiar colors. These chromogenic properties may be varied by various conditions of growth.

Examples: Micrococcus luteus—yellow.
Micrococcus aurantius—orange.
Micrococcus prodigiosus—red.

2. *Saprophytic Forms*, those growing in putrefying materials, causing putrefaction. Examples: Micrococcus fœtidus—causing a disagreeable odor, probably causing the odor in carious teeth. Micrococcus tetragenus, found in phthisical cavities in the lungs, and sometimes in the sputum in cases of phthisis. Micrococcus urea, in decomposing urine. Sarcini ventriculi, in acid dyspepsia.

3. *Pathogenic Forms*, causing disease.

Pyogenic forms—pus producing;
As Staphylococcus pyogenes aureus—yellow.
Staphylococcus pyogenes albus—white.
Staphylococcus pyogenes citreus—lemon yellow.

Streptococcus pyogenes in phlegmonous inflammations and rapid general suppurations. Streptococcus erysipelatis in erysipelas. Gonococcus—gonorrhœa. Pneumococcus (diplococcus pneumoniæ), an encapsulated form, the capsule surrounding two of the cocci; in dneumonia. This organism is detected in pneumonic sputum, and is the cause of the disease. It is not found in all pneumonias, and pneumonia may be produced by other organisms. Normally the organism is often found in human saliva. Many other diseases are supposed to be due to micrococci, including measles, scarlatina, whooping cough, diphtheria, smallpox, vaccinia; but this is not positively proven. In the lower animals a number of diseases are undoubtedly due to micrococci, as the septicæmia in rabbits and silk-worm disease (La Flacheric), which latter is caused by micrococcus bombycis (Pasteur).

(*b*) **Bacilli.**

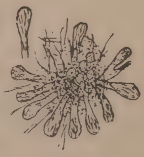
1. *Chromogenic Forms*, as B. prodigiosus.

2. *Saprophytic Forms*, as B. subtilis (white), which is a common form, slender and long, and called "hay bacillus" (in decomposing vegetation); B. of lactic acid, causing souring of milk, lactic acid being a product of such fermentation; B. vulgaris, found in putrefying flesh; Bacterium termo (of several varieties), frequent in decompositions; B. coli, a very common organism found in intestines and dejecta.

3. *Pathogenic Forms.* B. anthrax, the earliest and best known (Pollender, 1859), causing anthrax; B. typhosus, causing typhoid fever; B. tuberculosis, in tuberculosis, stained with difficulty; B. lepræ of leprosy; B. of glanders, and the disease syphilis is supposed by some to be due to a bacillus (Lustgarten). This latter is not proven.

(*c*) **Spirilla.** Of these we have a few *pathogenic forms:* Comma bacillus of Koch in intestines of Asiatic cholera; spirochæta Obermeyerii in blood of relapsing fever.

(*d*) **Peculiar Form.** *Actinomyces*, a form of growth occurring in actinomycosis or "swelled head," or "swelled jaw" of cattle, in which the arrangement of the individuals is in rays. By some it is placed among the *higher fungi;* by others among the *bacilli.* This concludes the *Protophytes.*



Actinomyces.

Hyphomycetes or Moulds.

Among the *higher fungi* some are capable of producing disease. These fungi are capable of producing filamentous threads or *hyphæ;* hence the name *filamentous fungi* often applied to them. The grouping of the hyphæ makes up the *mycelium* (representing the stalks, etc., of plants). These hyphæ may branch from *conidia* (spores within or upon the ends of the hyphæ or "fruit-bearers"). The organs of fructification then are at the end of the hyphæ.

Some of the moulds are of importance, as the edible fungi (mushrooms, etc.). These are sexual in their growth, and are known as *Hymenomytes*. There are several forms of moulds that may be pathological. A mould which in large numbers presents a green mass is the (*a*) *Penicilium Glaucum*, the fruit-bearing organ dividing into *sterygmata*, which are brush-like, hence the name. (*b*) *Aspergillus*, the end of the hyphæ *sterygmata* being spherical or pear-shaped, the conidia being thrown outside of this fruit-bearer (exogenous). A number of these forms also exist, as A. Niger, A. Flavus, A. Fumigatus. It has been inoculated into lower animals (as A. Fumigatus). (*c*) *Mucors*, which are large and can be seen by the naked eye, presenting a velvety appearance in their growth on surface. The conidia form inside (endogenous) the spheres or *sporangii*, at end of hyphæ. These are capable of growing in liver and lungs of lower animals. (*d*) *Oidiums* (or fungi that are a bridge between yeasts and moulds), having no fruit-bearer, are common pathogenic forms in man in skin diseases, as in Thrush, due to oidium albicans; Favus, due to Achorion Schonleinii; Tinea tonsurans(ring-worm of the scalp), due to the trichophyton fungus. Among the skin-disease-fungi may be named *microsporon furfur* (causing Pityraisis versicolor or liver spots), the fungus consisting of slender hyphæ, and growing conidia in some of the hyphæ. The growth is marked by a matting of the filaments. *Trichophyton tonsurans* (causing Herpes tonsurans or barbers' itch) differs from microsporon furfur in that the hyphæ are larger and thicker and contain more conidia.

Saccharomycetes.

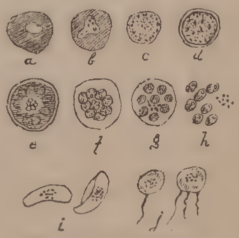
Saccharomycetes (or yiests) are unicellular vegetable organisms of the class of fungi of a round or oval shape, growing by *budding* and sometimes occurring in chains or in masses, presenting a slightly granular appearance. Examples are:

Saccharomyces cerevisiæ or *Torula cerevisiæ*, ordinary yeast used in making bread and causing fermentation, as of beers.

Examination of Yeasts and Moulds. Best examined in the unstained condition. Take a small colony (as in a scab from child's head), rub it up with a mixture of alcohol and a few drops of liquor ammonia to get rid of air bubbles; of this a little is placed upon a glass slide covered with a drop of glycerine, and, the cover glass pressed upon it. If the preparation is to be saved the cover glass is secured by sealing-wax around the edges.

ANIMAL PARASITES.

1. Protozoa, the lowest in the scale, and composed of a single cell. We are interested in the following divisions: (*a*) *Rhizopoda*, to which the class of *amœba* belong, as the " Amœba Coli " discovered in Egypt and found in the majority of cases of dysentery. These amœba tend to penetrate the mucous membrane of intestines, giving rise to inflammations and all the symptomatology of dysentery. By being carried by the circulation into liver, hepatic abscesses occur, as sequelæ of dysentery. The amœbæ can be examined readily in warm, fresh stools, and present amœboid movements. Each one " varies in size from five to ten times that of a red blood-corpuscle " (Stengel). (*b*) Certain forms of *Infusoria* (not so important as Rhizopods), not frequent in production of disease, but are often found normally in vaginal discharges; in the intestine, and may be found in the mouth of man. (*c*) An important class is the *Sporozoa* (produce spores), to which the *Coccidium Oviforme* belongs (producing fatal results in rabbits). The *Plasmodium Malariæ* seems to belong to the Sporozoa also, and it resembles the Coccidium very closely. The Plasmodium is found inside the *red blood-corpuscles* in all cases of malaria, and presents the following changes in its life-history: (*a*) First found as an irregular pale body in an otherwise normal r. b. c. The corpuscle simply looks paler in one spot. The plasmodium in this stage presents typical amœboid movements. (*b*) The organism has grown and caused distinct alterations in the red blood cell, which becomes paler, the organism darker, and containing granules of pigment. Here, also, there is an amœboid movement, the body moving within the corpuscle, and further the pigment granules have a peculiar motion of their own (*Brownian motion*). (*c*) This is a larger form than (*b*), in which the red corpuscle is completely filled. It is full of pigment granules, which are large and distinct. The cells containing this form, when stained, present a double contour, (*d*) the inner being the outline of the organism, the outer that of the blood disc. (*e*) This micro-organism, after it has grown to its full size and has destroyed the red blood cell in which it was originally, begins to divide itself by



Plasmodium Malariæ.

a form of *endogenous* cell formation, the embryo-plasmodia showing as a *rosette* of round or oval cells within the adult about the central deposit of pigment; (*f*) and (*g*) represent a still further stage in the separation until the protoplasm of the corpuscle is split, (*h*) the pigment and rosette individuals floating out into the blood, the embryos each preserved of amœboid movement, and presenting various shapes. These penetrate into other red corpuscles and begin again the cycle of growth.

The above forms are found associated with the various stages of acute malaria, the different forms corresponding with the different stages. The form (*c*) is most frequent just before the paroxysm (*Golgi*). When the organism reaches this full growth (in about four days usually) the *chill* comes on, due to the systemic disturbance of the young plasmodia being thrown into the system at once. Hence the *quartan* malarial fever is typical, the chill taking place when the rosette breaks. In other forms of malaria (as tertian, quotidian, octan) the chills are explained in the same way, it being supposed that several crops of plasmodia are developing at the same time, or that a single bunch grow more or less rapidly than is usual. We do not know actually how this organism gets into the body (for it has not been seen except in the blood). It is supposed to have another form outside the body, and there a different cycle of growth (perhaps in the mosquito), as other coccidiæ. (*i*) *Crescent-shaped* bodies have been found especially in chronic malarias (malarial cachexia). The *crescent* is found *outside*, but often *attached* to a pale red blood corpuscle, a few granules of pigment being found within this organism. This crescent becomes oval (pigment then being in the center or at the poles) and finally circular. (*j*) *Flagellate forms*, some supposing these to be modifications of the last. The flagellæ vary in number and position, and have a rapid motion. If the organism is at rest it is impossible to make out the flagellæ, the index of refraction being so near that of the blood plasma. These forms are especially found in the blood from the spleen.

Isolated flagellæ are sometimes found.

In acute malaria the plasmodium is found in greatest abundance just before the paroxysm, and almost all of the individuals disappear for a time after the paroxysm. This organism, the *plasmodium malariæ*, is decidedly affected by the use of quinine, and after administration of this drug quickly disappears from the blood of the patient. It has never been artificially cultivated, but inoculation with blood of a case of malaria has seemed to produce the same paroxysms in the subject inoculated. The white blood corpuscles seem to be especially abundant during malarial attacks, acting as *phagocytes* to the destruction of the plasmodia. The plasmodium seems to produce the malarial manifestations by destruction of the red globules, causing them to degenerate, and their hæmoglobin to be deposited in granules. Occasionally these pigment granules act as emboli, blocking up the capillaries and finer arterioles, especially in the brain, thus producing secondary effects.

Demonstration. The germ is found in the blood. The process of demonstration follows:

(*a*) A thin film of blood is spread upon the slide or cover, and dried rapidly by heating moderately.

(*b*) Pour over it a solution—alcoholic or watery—of methyl blue, and leave for a few minutes.

(*c*) Wash out the evident color with alcohol, and mount. By this means the plasmodium is stained blue, the blood corpuscles remaining greenish-yellow.

Description. The organism was discovered by Laveran, working in the French possessions in North Africa, in Algiers. His observations have received strong confirmation from such observers as Councilman and Osler in this country.

II. Metazoa, animals made up of numbers of cells or tissues.

Cœlomata, animals having a body cavity.

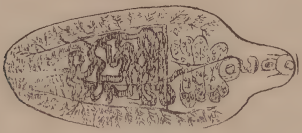
Division. **Vermes** or **Worms.**

Class I. Platyhelminthes (or flat-worms).

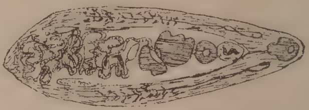
Order I. Trematodes. Of these there are several forms. The genus of most interest to the pathologist is *Distoma*, or flukes.

Of this genus the following occur as parasites in man: *D. hepaticum*, *D. lanceolatum* and *D. hæmatobium.*

Distoma hepaticum is frequent in the ruminants, and occurs occasionally in man. It is usually found in the biliary tract, whence it may get into the stomach and perforate the gastric mucous coat. It is a flat worm, with a narrow anterior end, the posterior end being wider and rounded. It is from 3 to 5 mm. in length (often reaching 20 to 25 mm.). At the anterior end, on the ventral surface, are two *suckers*, and between them the *genital pore.* It is rarely found in man, but is thought by some to be causatively associated with progressive pernicious anæmia, both this form and *D. lanceolatum* (besides other parasites), having been found in groups of men—miners in St. Gothard's Tunnel, under the Alps—who were subjects of this malady.

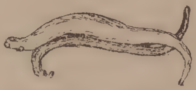


Distoma Hepaticum.



Distoma Lanceolatum.

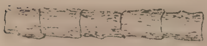
Distoma Hæmatobium occurs rather frequently in man in certain localities, especially in Egypt. It lives usually in the portal system, living upon blood. From the portal system the ova may penetrate into the pelvis of the kidney, where it causes inflammatory symptoms, purulent pyelitis, hemorrhages, or may act as a nidus for calcareous concretions. The sexual apparatus is separate in the two sexes. The male is from 12 to 14 mm. long; the female, 16 to 19 mm. The sexuality is peculiar, the sexes always being found together, the female enclosed in a groove in the posterior part of the male, formed by a rolling inward of the edges of the male.



Distoma Hæmatobium.

Order II. Cestodes or *tape-worms*, of which the most important is the genus *Tænia*.

General Considerations. Tape-worms, as met in the human body, exist as *strobila*, consisting of a chain made up of links or segments. The segments themselves are called *proglottides.* Each of these contains bisexual generative organs. The male organs are usually small and inconspicuous, but the female are large and constitute a feature for diagnosis. The latter consist of branching tubes, the arrangement of which differs in different species.



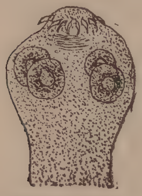
Strobila, Proglottides.

The long strobila gradually tapers at its upper end to a fine neck, which terminates in a head, clinging to the mucous membrane. The head contains sucking apparatus, or hooks, for anchoring the animal to the intestinal wall. This is the adult animal, each segment containing both sexes, the uterus prominent and full of innumerable eggs, capable of developing into worms. The links or segments are discharged from the intestines, the eggs escape and are swallowed by some lower animal (man being the host of the adult worm). As soon as the egg finds itself in the stomach of the second animal, the envelope or shell is dissolved by the gastric juice, and the little embryo set free. This is called the *proscolex.* It possesses a boring or perforating apparatus, with several spiculæ at its head. By means of this apparatus the proscolices perforate the mucous membrane and wander to all parts of the body—most frequently seeking out the liver and muscles for their seat. Arrived in either of these localities, the embryo, having grown somewhat, undergoes slight changes and becomes a *scolex*, remaining at rest and becoming surrounded by a capsule. The spicules are lost, and in general the scolex consists of a head inverted in a sac. The scolices remain thus as long as the animal lives. Thus encapsulated, they are visible to the naked eye, and in beef or pork constitute what are known as "measles." They may die, and are then apt to become calcified, especially the capsule, causing a gritty feeling in the tissues.

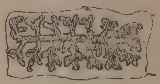
If the second animal be killed for its flesh while the scolex still lives, the worm finds a place for its final, mature growth. Being swallowed with the meat of the slaughtered animal, the scolex has its capsule dissolved in the gastric juice, the head emerges from the sac, the neck begins to produce proglottides, and the adult worm develops, being sometimes several yards in length. The above outline speaks of but a simple scolex. There is also a compound form of scolex, growing to enormous masses, of multiple scolices. This is the form most frequently found in man, the adult worm infesting the lower animals.

Genus Tænia.

Tænia solium, the pork tape-worm. The adult worm lives in the intestines of man, the *scolex* infesting the flesh of the hog. The eggs discharged from the intestines of man are taken up by the hog, and, having reached the stomach and intestines, bore out into the muscles, where they constitute "*measles*." If the meat of the hog be eaten, these measles again become adult worms, providing the cooking process has not been thorough enough to kill them. The head of the *Tænia solium* is about the size of the head of a pin, of a bulbous form, and terminating in a thin neck, and presenting at the end *four* small openings or "*suckers*." Between these suckers there is a crown of little teeth or "*hooklets*" (called the "*rostellum*"), which assist in the attachment to the mucous membrane.



Head (enlarged). Tænia Solium.

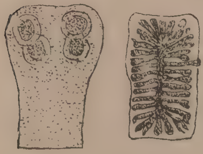


Proglottide (showing sexual apparatus). Tænia Solium.

The *Tænia solium* may grow to the length of two or three meters. Its rostellum contains twenty-six or twenty-seven hooklets. The neck does not contain segments. At its end segments begin to develop, but, for as many as 450, they are imperfect. The fully developed proglottides are usually longer than wide when quite old, but in the middle they may be shorter and broader. The opening of the sexual organs presents itself at the edge, alternating in adjacent segments. From this sexual pore a canal leads into the main cavity of the uterus, which presents six or seven secondary canals, which may again redivide. These canals are rather thick, and the tendency to ramify is not so marked as in other worms generally. While the hog is usually the host of the scolex, it is possible that man may take that place. In this case the *proscolices* may perforate the intestinal walls of man, and be deposited in the tissues as *scolices*. If their seat be in the muscles, no special symptoms are produced, but if they be deposited in important organs, as in the nervous system, marked disturbances may be caused. The scolex under these circumstances is called *Cysticercus cellulosæ*. A point at which such deposit is sometimes demonstrated is in the eye, the opthalmoscope revealing it.

Thus man may be the host of the strobila (*frequently*) *or the scolex* (*rarely*) *of this worm.*

Tænia mediocanellata or saginatta (beef-worm) is *longer* and usually *broader* than the last. The life history is complete in man, the *scolex* having been received from the beef. This is the *most common* tape-worm in this part of the world. Its life history is analogous to that of *T. solium*, except that the scolex is *never* found in man.



Head and Uterus. T. Mediocanellata.

The head of *T. mediocanellata* is a little longer than that of *T. solium*, and has *no hooklets*. The links, as a rule, are no longer than those of *T. solium*. The middle segments are here also relatively the widest, the lower ones being longer. Under a low power the genital outlet is seen to be arranged the same as in *T. solium*. The uterus of *T. mediocanellata* consists of a much greater number of branches, which are more delicate and ramify in greater number than in *T. solium*. The eggs of these two worms present little or no difference to the ordinary observer.

Tænia elliptica, found in dogs and cats; quite small.

Tænia nana, a dwarf form about 2½ to 3 mm. long, and about ½ mm. broad. Occurs in great numbers in the intestines. Very rare as a human parasite.

Tænia echinococcus. As far as its general history is concerned, this worm is similar to the above forms. *Clinically*, however, it is peculiar, the *scolex only* being found in man, the mature form infesting the lower animals, especially the dog. The mature worm is minute, and the canine intestine is found crowded with them, clinging to the walls. The mucous membrane seems to be covered with prominent villi (they are 3 or 4 mm. long); and if placed in water these villous-looking worms float out and make the mucous surface like velvet. The worm consists of but *four segments* and the *head*. The *first three segments are very small*, the *fourth* being *longer* and *larger* than the rest together. The head presents a crown of hooklets, about forty in number, and outside of this *rostellum* are *four suckers*. The scolex gives rise in man to serious disturbances, the *hydatid cysts;* such a hydatid being a *compound scolex* growing to a very large size and producing innumerable bladders (the entire mass being called the "*hydatid*"). The scolex is surrounded by a cuticle (of connective tissue), lined on the inner side with germinal cells, from which the *secondary cysts* develop. If the growth be within the capsule, the name *endogenous hydatid* is applied; if the scolex grow outward from the sac, the term *exogenous hydatid* is applied; this last form usually occurring in the lower animals. The original sac gives rise to secondary ones, and these again to another generation, and thus on—mother, daughter and granddaughter sacs. The form made up thus of great numbers of sacs is the real *multilocular hydatid*. The most frequent seat in man is in the *liver*, giving rise to enormous tumors, which may weigh several pounds, and occasionally removed by the surgeon. The next most frequent seat is in the *lung*, and after this they may be met with rarely in any part of the body—*kidneys*, *spleen*, *omentum*, etc.

Genus Bothriocephalus.

Bothriocephalus latus is also a tape-worm residing in man as a strobile. It is the *largest* of the tape-worms, reaching a length of *ten meters.* It is probably obtained by eating *raw flesh of fish*, where the scolex resides. The head is of a club shape, presenting two large slits on the opposite sides, acting as suckers. The proglottides are quite large, and differ from those of the Tæniæ. They are very broad, and the sexual opening is in the center of the link. From this opening the uterus branches out in a rosette arrangement. The *eggs* are also peculiar, being about twice as large as those of Tæniæ. It is oval, as usual in all tape-worms, and presents an *operculum* or *lid* at one end, opening for the emergence of the embryo. The scolex seems to come from fresh-water fish; the worm is, therefore, most frequently found in interior countries, especially in Switzerland.

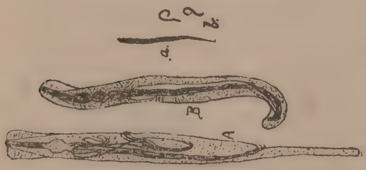
Class II. Nemathelminthes (or round worms).

Order I. Nematodes, round worms with long body, mouth and intentinal canal.

Genus Ascaris.

Ascaris lumbricoides. These are round worms, whitish or reddish in color, pointed at both ends. There are two sexes; the male is from 100 to 200 mm. in length, the female reaching about twice the length of the male. At the posterior end of the male there are two hooks, chitinous or horny material; the anterior extremity of the two sexes is identical. It is provided with three lips armed with teeth of chitinous material. The female produces a great number of eggs, which have a double shell and are coated on the outside with albuminous material. They are quite small, being 1-500 mm. (2 u) in diameter. The worm is rather a common one, especially in children. There are frequently as many as five or six in one individual. Their favorite habitat is in the small intestines, where they may wander into all parts of the intestinal canal from the mouth to the arms The life history of the worm is unknown.

Oxyuris vermicularis (thread-worm, seat-worm), a minute worm, 1 to 1.5 c.m. in length, looking like pieces of white or pink thread. The male (*B*) is about one-half the size of the female (*A*)—0.5 to 0.75 c.m. The favorite habitat is in the lower part of the small and large intestines. By their own motions they may find their way into the rectum and out of the anus, giving rise to intolerable itching about that part. They are thus often found in bed-clothes and napkins of



a and *b* are natural size.

children—hence the term "seat-worm." In the small intestines they usually exist in enormous numbers. The egg is flat on one side and somewhat kidney shaped. It is about $\frac{1}{500}$ mm. in length. The manner of infection is usually by autoinfection—the infected individual carrying the eggs to his mouth after scratching about the anus. Thus a single host may suffice for the life history of the worm.

Genus Stregyloidæ.

Anchyostoma Duodenale. This worm has a shape somewhat like that of the *flukes*, the upper end being round, the lower somewhat flattened. At the interior end there is a sucker armed with powerful hooks (jaws), and at the lower end the male has a pair of long hooks. The worm is from 5 to 10 mm. in length, and looks like a fine *red filament.* The favorite seat is in the upper part of the intestines, where they are found always attached to the wall of the gut by means of the sucker. This worm is rare in America, but has been found in some of the European countries, especially in mining regions. The simultaneous occurrence of these worms in the intestines of miners at St. Gothard's Tunnel and the presence of a progressive, pernicious form of anæmia in the same persons suggested a causal relation of the worm to the disease.

Genus Trichotrachelidæ.

Trichocephalus dispar is a rare form of intestinal parasite, occurring occasionally in this country. It presents no symptoms beyond those of other worms. It is several centimeters long. The anterior end is filamentous and whip-like—hence the name "whip-worm," the posterior end becoming suddenly larger. The eggs are $\frac{1}{500}$ mm., and have two bulbous projections at either end.

(*a*) Worm.
(*b*) Egg (enlarged).
Trichocephalus
Dispar.

Trichina spiralis is most frequently found in the larval form in the muscular tissue of man and some of the lower animals. It is found coiled up (one, two or three together) in a capsule. The capsule, with the worm coiled up within it, is about 1 mm. in length, and looks to the naked eye like a white dot in the flesh. The white appearance is often increased by calcification of the capsule. The further history of this is somewhat as follows: The flesh of the pork is eaten by man without proper cooking. The larva, being alive, and not injured by the insufficient heating, reaches the intestinal tract in the capsule, which becomes dissolved by the gastric juice and the intestinal fluids. In the intestines it reaches maturity in about 2½ days. It is a worm about 3 mm. in length (*i. e.*, the female, which is the larger). In seven or eight days the mature worm reproduces. The products of reproduction come from the mother's uterus as *minute worms* (10 *u* long), and make their way through the intestinal walls by perforating them, and are finally found in the muscle tissue of the same individual. The minute worm penetrates the lining membrane of the muscle fiber (sarcolemma), and within this forms the capsule above described. During its travels it has grown somewhat, and after lodging it increases slightly until when enveloped in the capsule it may be seen with the naked eye. The early part of its life (in the intestine) is very short, but in its encapsulated form it may live indefinitely. Should the "*measle*" die before its host, calcareous infiltration is marked; but slight calcification does not necessarily indicate that the animal is dead. The danger of trichinæ comes from eating uncooked or poorly cooked pork. The symptoms classify themselves as *intestinal*, *muscular* and *general*. Recalling the fact that each mature female produces from 1000 to 1300 embryo worms, and that these all penetrate the intestinal walls at the same time, the catarrhal symptoms are easily realized. Following this come local troubles in the muscles, due to perforation of the sheaths and the encapsulation. The muscles are painful and swollen, and œdema of the lower extremities is likely to set in. These symptoms are usually accompanied by fever, and often terminate fatally. The muscles of the trunk are the most frequent seat of lesions—the diaphragm, the muscles of the neck, and the body muscles generally.

Trichina Spiralis.

General Features of Helminthiasis. This term designates infection by intestinal worms. The symptoms caused by echinococcus and its tumors are only those due to mechanical effects, as from pressure, in important organs. The other intestinal worms, however, produce a number of symptoms of a *reflex* nervous nature (manifesting themselves through the nervous system at a distance from the habitat of the worm). The intestinal irritation may produce varied phenomena—convulsions, aphasia, etc., etc. Local disturbances are at times produced, especially by *Ascaris lumbricoides*, which may rarely perforate the intestinal wall, or enter and obstruct the various channels communicating with the intestines, as the biliary passage. This worm may by its own motion wander out of the anus, or enter the stomach and mouth. At least one case of strangulation by obstruction of the larynx is recorded. (See Univ. Med. Museum.)

Genus Filaridæ.

Filaria sanguinis hominis. This parasite was long thought to live only in tropical countries, but is found as far north as our Southern States. It was first discovered as an embryo, in which form it inhabits the blood of man in enormous numbers—a cover-glass preparation showing at least two or three worms. The embryo is a slender filament, of the thickness of the diameter of a red globule, and ¼ mm. in length. As to the further history of the vast majority of these embryos nothing is known. Some, however, are withdrawn by mosquitos. The blood taken by the mosquitos is found to contain an excessive proportion of embryo filariæ, probably because the *proboscis*, when thrust into the affected circulation, serves to entangle them as they are carried along by the blood. In the mosquito the embryo grows. Only three or four of those taken in thus grow, the others being destroyed. These three or four reach their full growth about the time the eggs are deposited in water, and they may be discharged at the same time. After this the insect dies, and if the filaria has not escaped with the eggs, they now get into the water, whence they gain access to the intestines of man. Still, in the embryo form they pierce the intestinal walls, producing no symptoms because of their smallness and fewness. They gain their habitat, the lymph vessels, a male and female being together, and have no tendency to migrate. Here the full growth (7 to 8 c.m. in length, and of the thickness of a pair) is reached, and reproduction occurs, the female extruding an enormous number of fully formed embryos. These pass on into the blood, and are present there in great numbers, but, curiously, only at night. As a rule, but a single pair of adult filariæ may be found in one person, the female constantly giving forth young. The symptoms produced are many and varied, almost all the result of lymphatic obstruction (elephantiasis almost always is the result of such obstruction, and usually in the lower parts). The real cause of obstruction is the immature condition in which the embryos are sometimes discharged, being coiled up in a mass, while, when mature, they are never so coiled, and are thin enough to pass along through the smallest vessels. Of the glands, those of the groin quite frequently serve as a habitat of the adult worm—hence the frequent filarial obstruction in the legs and scrotum.

Division. **Arthropoda** (membered Metazoa).

Class, Arachnoidæ—Spiders.

Acarus scabies (*Sarcoptis scabiei—Itch*) is a form of *mite*, size of head of small pin, somewhat the shape of a turtle. The head is armed with powerful jaws, and on the ventral side, in front, are two thick-jointed projections having *suckers*. The female is especially apt to perforate the derm by means of the strong jaws, depositing ova all along the channel of perforation.

Acarus folliculorum (*Demodex folliculorum*), a slender animal, 0.2 to 0.3 mm. long. It is not as highly developed as *A. scabiei*. It resides in the retained matter of sebaceous glands (comedones), which may be squeezed out and examined under the microscope. There seems to be no casual relation between these and comedones, as they occur only in some individuals.

Besides the above, a number of other parasitic insects should be recalled, as *fleas*, *bed-bugs*, *etc*. The disease caused by lice (*Phtheiriasis*) should be mentioned. The term is applied where the skin is markedly involved, ulcers being formed, and the lice not infrequently being found in burrows underneath the scabs. When such marked dermal involvement is absent, the term *Pediculosis* is used. Of *lice* there are three varieties: the "*crab-louse*" (*Pediculosis pubis*), found in the pubis and sometimes the axillary hair; the head-louse (*Pediculosis capitis*); and the body-louse (or *P. corporis*), found on the body and clothes. The crab-louse and head-louse deposit their eggs upon the hair, in a glue-like mass adhering to the hair ("*nits*"). In the case of body-lice the ova are deposited in the clothes. These lice do not penetrate the skin, but produce their effects by biting and sucking the blood.

(THE END.)

External appearance

[illegible] fleshy, smooth

Cancer More nodular
irregular outline Or constitutes
an unhealthy ulcer Papillary
growths towards border of ulcer
Base of ulcer indurated

When cut into
In sarcoma Milky color
smooth surface Often with
a distinctly reddish tint
Cancer Not so smooth
is more opaque Less apt
to have a redish color

Juice Exuded
Absent in sarcomas
Present " carcinomas

Presence of Adipose Tissue in carcinoma
Absent in Sarcoma
May be present in cancer

Capsule Capsule
Sarcoma more apt to have
of more or less evenly outlined
Rare in carcinoma

Relation to surrounding
structures.
Sarcoma has no tendency
to infiltrate localy. While
cancer does.
Consistancy
Sarcomas Softer
Carco harder
Relation to skin
Sarcoma does not adhere
to skin.
Carcinoma does adhere
to skin and skin unhealthy
Pain
absent in Sarcoma
Present . . cancer
Neighboring lymphatic
glands Metastisis ~~present~~ absent
in Sarcoma Present in cancer
Sarcoma grows rapidly cancer
slowly but more rapid than any other
non malignant tumor.
Sarcoma occurs in middle life
cancer after middle life
Sarcoma grows in con. tis. in general
carcinoma Epithelial surfaces and lymph
glands
Sarcoma cells are embryonal
con. tis. with slight intercellular
substance between
Cancer epithelial cells only.
Sarcoma. Intercellular substance

small in amount and embryonal
Carcinoma it is fully formed fibrous c.t.
Sarcoma Blood vessels embryonal Walls
often absent
Cancer. Blood vessels fully formed and
carried in con. tis.

Classification of Tumors as to Shape

1st Uniform Swelling
as Lymphoma Goiter and sarcoma
of organs.

2. Nodes - Growing centrally.
all benign } as Fibroma, Myoma Lipoma
Neuroma Adenoma Malignant
secondary metastatic tumors

3. Nodes. - By Infiltration.
as Sarcoma and Cancer

4. Tubers. - or partly protruding tumors
and always covered by skin
as, Chondromas, Osteomas,
and osteo chondromas

5 Desquamation
as Ichthyosis or fish skin disease

6 Flat Tabular Swelling
a. Especially the epithelioma } Squamous cylindrical Lupus
b. Benign Angioma et Lymphangioma

7. Hemispherical Growth. Fibroma,
Keloid, Chondroma, Osteoma. This form
is covered with skin.

8. Fungoid Growths.
as Telangiectatic Sarcoma and Cancer,

9. Dendritic
as Benign Papilloma
" Malignant Epithelioma Squamous.

10. Polyp.
as Fibroma } Myxoma, Adenoma
and Bovine tubercle.

Bacillus of

Bacillus of Tubercul

Catarrh

Abscess

1) Minor

2) Large

11. Wart.

as

12. Cys

hydrocele

as tho

rhage

ced by

degenerat

ement

l fluid

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